

Analysis of Alternatives and Socio-Economic Analysis

Public Version

Legal name of applicant: Custom Moulded Polyurethane Limited

Submitted by: Custom Moulded Polyurethane Limited

Substance: 2,2'-Dichloro-4,4'-methylenedianiline (MOCA, MbOCA) [CAS 101-14-4; EC 202-918-9]

Use title: Used in manufacture of hot cast polyurethane components

Use number: 1

Application for continued use of MbOCA
Submitted by: Custom Moulded Polyurethane Ltd

ANALYSIS OF ALTERNATIVES REPORT (AOA)

Including

SOCIO-ECONOMIC ANALYSIS

Date: 20th May 2022

Legal Name of Applicant: Custom Moulded Polyurethane Ltd (Abbreviation CMP)

Company Number: 4858251

Submitted By: Custom Moulded Polyurethane Ltd (Abbreviation CMP)

Substance: 2,2'-Dichloro-4,4'-methylenedianiline (MbOCA) [CAS 101-14-4]
(Abbreviation MbOCA)

Industrial Use of: 2,2'-Dichloro-4,4'-methylenedianiline (MbOCA) for manufacture of hot cast polyurethane components

Use Number: 1 use

Average Annual Usage: 3,000 kilos (250 kilos per month)

Authorisation Period Requested: 8 years

Analysis of Alternatives: (Abbreviation AOA)

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SECTION 1: INTRODUCTION

MbOCA as a “substance of very high concern” has been placed on the Authorization List under the Europe’s Registration, Evaluation, Authorisation & Restriction of Chemicals (REACH) regulatory regime.

Should any UK based polyurethane processor wish to continue to use of MbOCA following BREXIT, they are required to apply to UK Reach (HSE) to demonstrate that they, as a Polyurethane processor cannot find a suitable substitute for their specific critical cast component parts.

Also demonstrate that they process MbOCA safely, having procedures in place to protect employee’s health as far as reasonably practicable.

CMP would like to comment that after contacting other UK polyurethane processors, there seems to be confusion amongst some processors as to what is required regarding the current MbOCA use situation in the UK. Indeed, one company commented that they were expecting their suppliers to solve this issue for them! As a result, some processors may not be applying for authorisation as they are unaware, they need to do so.

One such company has contacted CMP to enquire what they need to do, CMP suggested that they contact Reach UK (HSE).

SECTION 2: COMPANY BACKGROUND

Custom Moulded Polyurethane Ltd was founded April 2004, a small family run business currently employing 9 staff, 3 admin plus 6 direct process operators, only 3 of which work with MbOCA.

Current average annual usage of MbOCA = 3,000 kilos, mainly used to supply the engineering industry sector, supplying smaller integral component parts for larger pieces of equipment designed and developed using TDI / MbOCA cured polyurethane where high tensile strength is essential.

Prior to founding CMP, the company's MD was employed by a large polyurethane processing company for over 32 years, employing 36 process operators. This company initially only processed TDI/ MbOCA cured polyurethane systems.

Commencing employment in 1972 as a process operator, he cast components by hand /batch mixing using TDI/MbOCA cured polyurethane, manually melting out MbOCA using hot plates followed by weighing out TDI prepolymers and MbOCA to be mixed by hand using a bench mixer, later followed by low pressure dispenser casting.

Following several years as a process operator he moved into managerial roles as production manager followed by production director, responsible for all aspects of daily production including health and safety, focussing on the safe handling of MbOCA and Isocyanates in the workplace.

During 30 plus years employment, working with HSE on several occasions, he gained a high level of knowledge regarding the use, risks and safe handling procedures associated with processing MbOCA.

He worked closely with the HSE during their several site visits, to investigate safe MbOCA handling procedures, such as correct PPE to protect process operators, swab detection of MbOCA to track its level of contamination in all areas of the workplace, including washrooms tea rooms and toilets, swab testing of freshly cast components, analysis of operators used gloves for any trace of MbOCA contamination, plus workplace air monitoring.

He was responsible for setting up extensive improvements regarding safe handling systems and procedures regarding working safely with MbOCA.

Following completion of the much-improved MbOCA processing procedures the HSE stated that they would use the end results as an example for other UK based polyurethane processors to adopt, these safe measures/procedures to be used when working with MbOCA.

This extensive H&S exercise overseen by HSE, proved to be an excellent educational experience regarding the safe handling of MbOCA greatly reducing biological monitoring results. The same safe working procedures were later adopted by CMP, made much easier to implement on a smaller scale, only having a maximum of three process operators working with MbOCA and isocyanates.

The MD of CMP has been working with MbOCA for 49 years to date therefore gained a very good understanding of its function as a very versatile process friendly, low-cost polyurethane curative. However, he is also concerned regarding its suspected health issues, labelled R45 risk suspect human carcinogen (bladder cancer) therefore has continually been and still is seeking suitable alternatives.

Experience/Knowledge of working safely with MbOCA

The information detailed within this application for (authorisation for continued use of MbOCA) are based on a combined “hands on” processing experience of more than 66 years working in the industry processing MbOCA cured polyurethane systems.

During this time CMP have gained a vast knowledge and expertise in processing the range of polyurethane systems commercially available both MbOCA cured and non-MbOCA cured systems, by batch (hand mixing) and processing through dispensing machines where larger castings are required.

CMP work with its raw material system providers inviting them to utilize their production equipment to ensure their polyurethane systems formulated in their labs process ok in a working production environment, casting large batches compared to the small samples they process in their labs, to ascertain processability parameters where it matters in a real production working environment, in terms of processing parameters especially regarding pot-life, de-mould times, green strength on de-mould etc.

Hot cast polyurethane is a unique process which is very diverse due to the vast range of end user applications.

The process of casting polyurethane is often referred to within the industry as being a “black art” (a process that is mysterious or difficult to master.)

SECTION 3: AOA

If there was a “drop in” replacement CMP would cease using MbOCA immediately.

Unfortunately, no such curative is currently commercially available. CMP have been seeking alternatives for many years, however like other processors this has been without success, (information on alternatives evaluated detailed later in this report).

Custom Moulded Polyurethane Ltd as the name suggests, specialises in the design and development of high tensile strength polyurethane components cast in TDI/MbOCA cured grades, frequently working with third party design engineers to produce components which require all round, high-end physical properties, abrasion resistance, tear strength etc. only suited to MbOCA cured systems.

Polyurethanes cured with MbOCA provide this requirement at a competitive cost, alternative curatives are available however not suitable due to their high cost, short **pot-life** along with other processing difficulties detailed later in this report.

MbOCA-cured polyurethanes are tough and durable they have better all-round technical performance than polyurethanes cured with alternatives. MbOCA cured components provide high load bearing capacity, good abrasion resistance, high tensile strength, compression set and rebound resilience. MbOCA still remains the preferred choice in the European cast polyurethane industry, it has been this way for decades. It is still the most widely used chain extender outside of the EEA.

Four alternative chain extenders were shortlisted in our AOA.

- DMTDA (*Ethacure 300*)
- MDI/1-4 Butane Diol
- MDI/HQEE. (*LFM E500 / VIBRACURE® 2101*)
- MCDEA

In addition to the shortlisted alternatives, there are other non-MOCA-based polyurethane systems that are not suitable to replace TDI/MbOCA due to their high costs such as, Addolink®1604, and Vulkollan

N.B. Whilst MCDEA is very expensive we did conduct some casting trials as detailed later in this report.

Rather than restrict test analysis of alternatives to tensile testing of cast samples our assessments were subjected to more demanding “in service” trials, with the help of some of our customers who agreed to test parts to compare performance against their existing **TDI/MbOCA** cured versions.

TDI/MbOCA cured polyurethane systems are **easy to process**. Small variations in ratios between MbOCA and TDI prepolymer +/-3% does not negatively affect the performance of end-products. In practice this results in a very low level of rejected parts.

Alternative systems such as MDI cured with 1-4 Butane Diol must be processed with the exact ratio +/- 0 parts to achieve good defect free parts, this results in a high reject level of parts, adding to process costs and expensive waste disposal regarding rejects which cannot be recycled. Unlike MbOCA cured systems MDI formulations are extremely difficult to mix by hand therefore force the processor to purchase expensive automated 3 components dispensers, providing they have the floor space available in the workplace to install them!

Pot life is the main advantage of the **TDI/MOCA systems**. The viscosity of the mixture remains low for a longer time typically 5-6 minutes for a 95 shore A hardness, permitting the manufacture of larger parts, in excess of 20 kilos, free of entrapped air pockets, flow marks and small air bubbles which have time to rise to the top of the casting prior to the polyurethane curing to its green solid state, lowering reject levels of cast parts. Most other alternative curatives have a short **pot-life**, the liquid polyurethane mix starts to cure during the casting process causing incomplete cast parts due to air pockets, air bubble entrapment within the cast parts.

As well as a short pot life, MDI grades also have very high exothermic reaction during the crosslinking of the prepolymer and curative, viscosity increases rapidly following mixing, preventing the cast mixture flooding all areas of more complexed moulds, especially into thin wall sections of a mould cavity resulting in rejected parts.

The **pot-life** of **TDI/MbOCA** grades can be further increased by processing at slightly reduced raw material temperatures without any detrimental effects to the cast parts in terms of physical properties, this is not possible using alternatives such as MDI which rely on high processing temperatures to produce good parts. Processing temperatures are even more process critical and higher since mercury was banned as a catalyst in MDI polyol during recent years.

Exotherm temperatures of **TDI/MbOCA** cured systems are low, plus long pot life, a slow increase in viscosity allowing the cast polyurethane to have enough time to “shake hands” and react with the chemical bonding agent resulting in good bond strengths to metallic components such as wheel centres, backing plates, bonded inserts etc.

Three component **MDI/1-4 Butane Diol** cured systems have a very high exotherm temperature, short pot life and a rapid increase in viscosity which is very detrimental to the function of the bonding agent applied to metallic objects, high exothermic temperatures degrade the bonding agent resulting in bond failures, the mixed polyurethane does not remain in its liquid form long enough, to allow it to fully crosslink with the bonding agent applied to metallic parts, it is intended to bond to due to its short pot life, full bond strengths are not established. Polyurethane tyres delaminate whilst in service on a forklift truck wheel etc. resulting in downtime and possible health & safety issues due to tyres bond failing.

CMP have and still are seeking alternatives for MbOCA collaborating with its customers, seeking their permission where possible to supply parts traditionally cast using MbOCA, with an alternative non-MbOCA grades.

The best test of any cast polyurethane system, is to check its suitability in service, as opposed to relying on documented physical properties, which may imply an alternative system is suitable on paper, then fails in service due to one or more physical property not being high enough for a particular demanding application.

In an attempt to move parts away from MbOCA, CMP have, where possible, used some of their customers as a test bed, supplying existing parts traditionally cast in TDI/MbOCA grades with alternatives providing the part specification was not specified as TDI/MbOCA cured grades, non-MbOCA alternatives at the same hardness were substituted without the customers knowledge, in order to remove any psychological issues preventing the customer from fully evaluating the parts.

Unfortunately, very few parts performed to the customers' requirements, therefore they were reverted to MbOCA cured parts.

Years of experience processing polyurethane have demonstrated that technical data regarding physical properties stated by raw material suppliers, only offer a guide regarding expected performance of their formulated systems, in terms of processability and physical properties. Documented physical properties sometimes fall short of their expected performance when cast parts are used to extremes in service.

Raw material suppliers state processing properties such as pot life, demould time etc. based on mixing and casting small samples typically 250 grams of their systems in their laboratory conditions, these results are often compromised when the same grades are processed on a larger scale in a production environment, **pot-life** is very often much shorter due to larger volumes of mix quantities, casting large parts which result in a much higher exothermic

reaction, reducing pot life, this occurrence also prevents casting the mixed liquid polyurethane into moulds which have thin wall sections, the cast parts have voids resulting in rejected parts.

MDI grades have a very high exotherm temperature resulting in a rapid increase in viscosity this greatly reduces to number of moulds that can be poured in a batch reducing production efficiency, increasing production costs.

Examples below of parts cast in non-MbOCA alternatives.

CMP have supplied re-bonded tyres for rotary plant wheels to water treatment works for many years, cast in TDI/MbOCA cured polyurethane @ 90/95 shore A hardness. There have never been any reported failures.

As part of our AOA, we supplied FOC sample wheels cast in three component MDI/1-4 Butane Diol cured, the physical properties of this alternative are good enough for this application, however the bond strength is not. PU tyre bond failed after approximately 48 hours in service (as pictured below).

Our customer has advised CMP that it is essential that all wheels supplied must be in the approved grade being TDI/MbOCA cured polyurethane as unscheduled downtime at the water treatment plant cannot be tolerated due to tyres bond failing.



The process of bonding polyurethane to a metallic component, in this case a wheel centre, is to first grit blast the surface of the wheel centre to which the tyre will be bonded. The next stage is to apply a coating of bonding agent to the grit blasted, clean face of the wheel centre and allow to air dry. The wheel centre is then loaded into the casting mould and heated to 90-100 °C. The polyurethane is poured into the heated mould cavity, it is vital that the **pot life** of the system being used is greater than the time it takes to fill the mould, if not then the cast item will contain voids or air bubbles resulting in rejects.

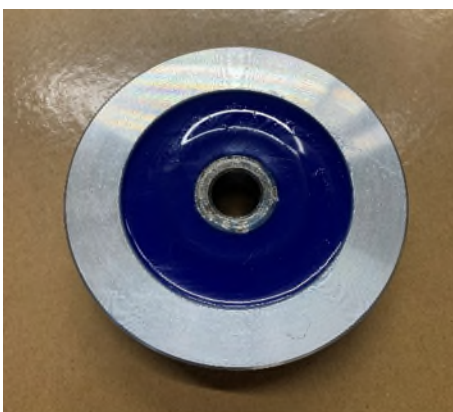
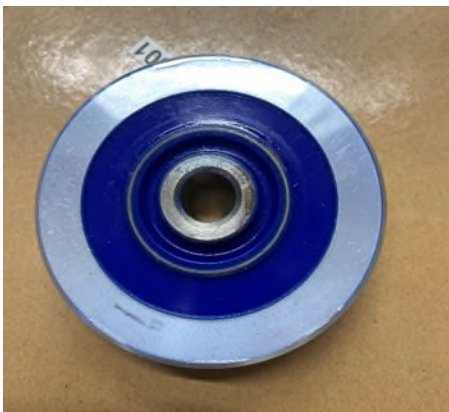
This is not an issue when using TDI/MbOCA cured systems as pot life is long and increase in viscosity of the mix is slow preventing air bubble entrapment, voids, and flow marks, plus plenty of time **to establish a good chemical bond of the tyre to the steel wheel centre**.

MDI systems short **pot-life**, high exothermic reaction and rapid increase in viscosity are all detrimental to obtaining good bond strengths.

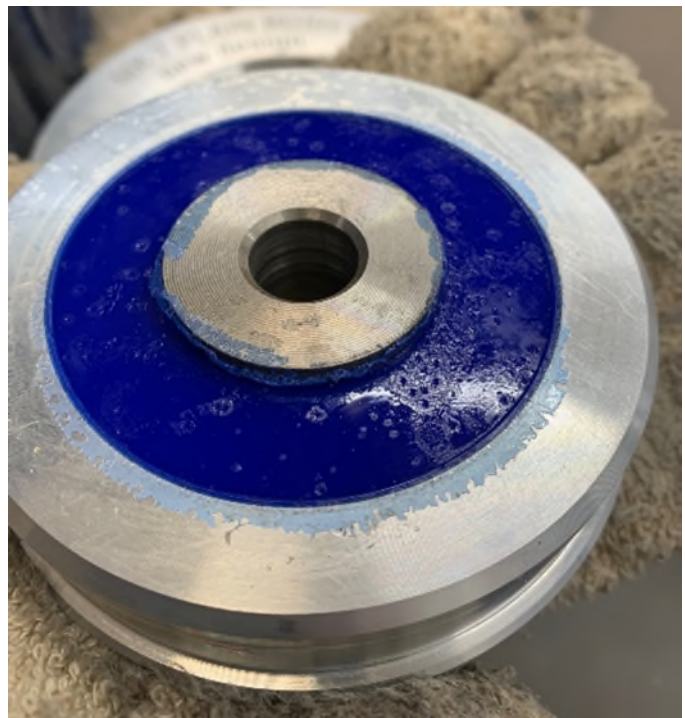
CMP manufacture a large volume of engine and gearbox mounts which were developed using TDI/MbOCA grades @ 80 shore A hardness. TDI polyurethane is required due to the high tensile strength required for this application, the parts are subject to extreme torque being fitted to high-performance cars. As part of our AOA, we attempted to cast some mounts in MDI grades and experienced a high level of rejects. Mode of failures ranged from air entrapment due to short pot life, slightly off ratio mix and excessive shrinkage onto the inner steel core, putting excess pressure onto the bond to the outer aluminium housing.

Pictures below show an example of air bubbles due to being slightly off ratio when cast in MDI plus a good part cast in TDI/MbOCA cure polyurethane.

TDI/MbOCA Good Parts



MDI Grade Rejected Part



Cast a batch of 100 mounts using 3 component MDI whilst fine tuning the casting procedure in terms of raw material, oven, and mould temperatures to find the optimum casting conditions to permit casting of good parts.

When the correct process parameters are identified, any very slight deviation will result in a reject “when you get it right it’s on the edge of being wrong” syndrome. This is not an issue when casting TDI/MbOCA as this exact process control is not required. We suffered a 60% reject level over the batch of 100 castings. The 40 good parts were despatched to our customer for evaluation who later reported issues regarding bond failures as detailed below.

To: [REDACTED]
Subject: product failures

Morning [REDACTED] we seem to be having some problems with your bonded parts failing this is the fourth one in 6 weeks and this one lasted 2 days in the car, the video is of a previous failure of the middle bush on a Mk 6 the red stuff was them trying to repair it, previously we have had very few failures of this nature maybe ½ a year, it appears that there is no or very little bonding between the steel ring and the urethane bush, up to this point I have covered the cost to the customer for these warranty related parts but at £178 per set as the whole item has to be replaced not just the bush I cannot afford to keep covering the cost, I am trying to get the part returned from Canada for your inspection, these parts are from your July delivery as we date mark everything for traceability, do you keep records of the bond / adhesion tests you perform on these?

*Paul [REDACTED]
Director*



Customer email complaint due to bond failure of engine mount bushes. We have supplied these engine mount bushes for many years in TDI/MbOCA grade without any issues. This batch were cast in MDI, in an attempt to move the job away from MbOCA.

As we suspected the issue is not connected with physical properties of the MDI polyurethane, it is related to bond failures due to short pot-life plus high exotherm temperatures generated when this grade crosslinks, causing degradation of the bonding agent.

These mounts are subjected to high levels of torque, fitted to high powered performance cars, good bond strength is essential.

Remedial Action: Reverted to TDI /MbOCA cured grade, no further issues reported.

CMP supply polyurethane coated rollers to a book manufacturing company, grade currently used for this application being TDI/MbOCA cured at a range of hardness's 60-95 shore A.

Casting trials were conducted on some of the roller range to assess the possibility of supplying in three component MDI grades. Casting trials did not go well due to porosity on the surface of the PU plus shrink back due to excessive shrinkage of this material.

We also experienced issues regarding pouring the short pot life MDI into the narrow mould cavity, viscosity increases too soon after mixing.

Pictures below clearly show the porosity and shrink back issue of these rejects:



We were unable to cast good quality examples of these small diameter thin wall section rollers using MDI grades.

Remedial Action

Reverted to TDI/MbOCA cured grades.

CMP supply flexible step mounts for a company who manufacture railway maintenance equipment, one mount on each side of a metal step attaching the step platform to the railway enabled excavator.

Cast a batch of 100 mounts using 3 component MDI/ 1-4 Butane Diol, suffered 25% rejects.

Cause being surface porosity due to moisture contamination of the polyol / 1-4 BDO component plus slight “off ratio” issues as pictured below.



Whilst the physical properties of this grade would suit this application the reject level is unacceptable and costly.

Remedial Action

Revert to TDI/MbOCA cure.

Bonding Issues

Picture below shows an example of customers wheels normally cast in TDI/MbOCA grade. Customer agreed to have them cast in 3 component MDI/1-4 butane Diol cured for evaluation. Tyres bond failed after a relatively short service life.

TDI grades do not suffer with this issue and have a much longer service life, not requiring re-bonded until the tyre diameter has worn down to the point where it needs re-bonding.

The diameter on the MDI tyres is hardly worn before the bond failed prematurely causing the tyre to breakup.

Polyester grade MDI polyurethane tyres also suffered with hydrolysis degradation.

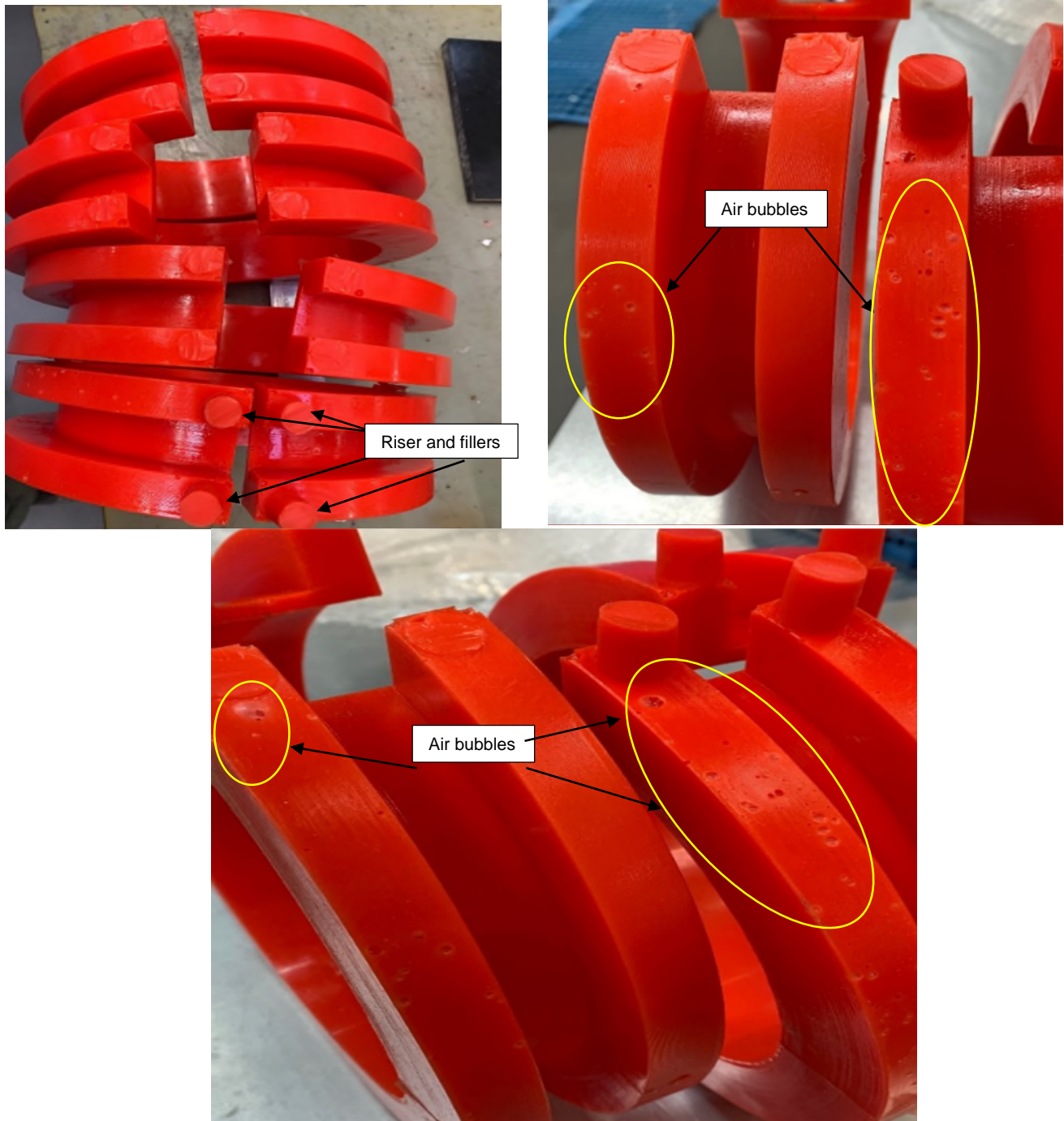
Customers do not expect to incur this downtime and replacement costs on a frequent basis, they are accustomed to the long life of TDI/MbOCA cured tyres with good bond strengths plus excellent all-round physical properties.



Remedial Action

Wheels were stripped of MDI PU remains and re-bonded in TDI/ MbOCA system free of charge.

Parts below cast in MDI grade rejected due to air bubble entrapment caused by short pot life. Mould is enclosed with filler and risers. Liquid PU is poured through 12mm diameter filling ports to flood mould cavity. Viscosity increases too fast during casting, causing air bubbles to become entrapped in the cast parts, instead of rising and entering the riser ports, which are later removed during finishing operations.



Remedial Action All parts rejected and replaced with TDI/MbOCA grade all of which passed inspection, no air bubbles, or voids.

[REDACTED]
Date: Thu, 28 Nov 2019 at 13:12
Subject: Rejects
To: <Cc [REDACTED]>

Hi Phil,

Received the Cutting Sticks yesterday. As far as size goes, there great.
However, quite a few of them are as photo attached.
In total I have 50 off rejects.
I know for a fact; my customer would not accept them.
With being the first major delivery, I don't want to give them any reason to reject them.
They're going to put the 200 off I've supplied straight on the lines.
As long as they are OK, I'll be ordering 450 off a month.
Will be back in touch ASAP.

Regards
[REDACTED]
[REDACTED]



Pictures above reference customer complaint, air bubble entrapment due to MDI having short pot life plus rapid increase in viscosity preventing bubble rising to the top of the casting which is removed when the cutting sticks are cut back to the finished length.

Remedial Action

Cast parts in TDI/MbOCA cured grade, longer pot-life allowing air bubble to rise to overpour area, removed when parts cut back to finished length.

Subject: Pad issues
To: Phil Thorne

Hi Phil,

Recently had a delivery of pads from you and have found a couple of quality issues to raise. We carry out a 10% visual check on pads, so on the latest delivery of about 300 pads, we checked approx. 30 and found some bad flow marks in 2 and porosity in 3. (I know sometimes we have seen small amounts of porosity, but this looks like a bit more than usual).

See attached photos, they do not show fully as it was difficult to get good images, it's just a point to raise as [REDACTED] are becoming more stringent on what they accept

Not going to reject anything this time but in the future if faulty ones are found in the sampling, our system shows to reject the total amount delivered, so don't want to go down that road.

Regards

[REDACTED]
Wheels Quality Technician
[REDACTED]
[REDACTED]

Phone : [REDACTED]



Complaint received from customer regarding the above forklift stabilising pads. CMP developed these pads back in 2009 using TDI/MbOCA cured system @ 95 shore A hardness and have supplied thousands of pads to date without any issues.

Due to these parts having a large open top without any small narrow sections the casting time is very short. This was a part which could possibly be cast in a non-MbOCA alternative with a short pot life. We cast some of the batch using M-CDEA an alternative to MbOCA. This curative is at least 6 times more expensive than MbOCA with a very short pot life even if we could supply good parts, we would not be able to pass on this high increase in costs to our customer, greatly reducing our profit margins. However, we proceeded if only to evaluate its

processability as its physical properties match and even exceed that of MbOCA cured systems.

Unfortunately, the results as expected were disappointing the very short pot life resulted in rejected parts. If we were unable to cast these open top moulds, then we would have no hope of casting other more intricate parts due to the very short pot life.

Air bubble entrapment and flow marks not acceptable to the end user as email feedback and pictures above.

Subject: Y403482 - Compliance Roller

Hi Phil,

We have been using the Y403482 compliance rollers that we purchased from yourselves last month, unfortunately they are more prone to cracking along the legs/splines? (Image attached)

Can you offer in a material that's more flexible?

Thanks

Technical Manager



Complaint received from a customer following CMP supplying these replacement MbOCA cure parts using Ethacure 300 as an alternative. This soft touch roller continually flexes in operation as it rotates at high speed.

Ethacure does not perform as well as MbOCA in this application.

No issues regarding parts supply previously cured with MbOCA.

Hi Phil,

Hope all is well at your end,

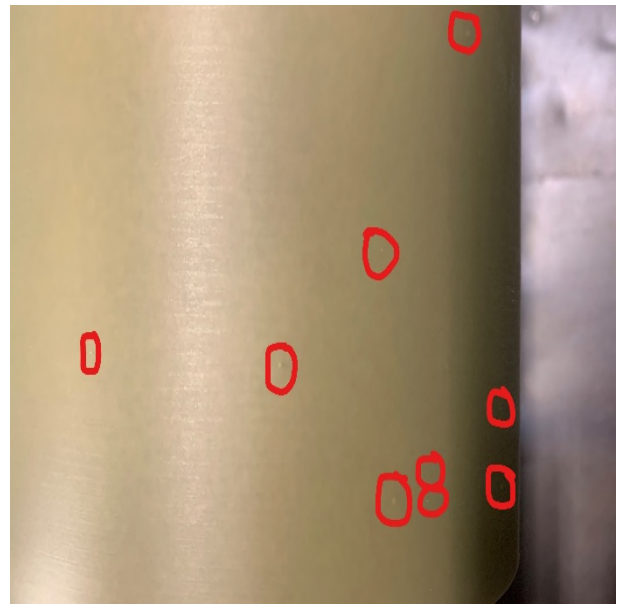
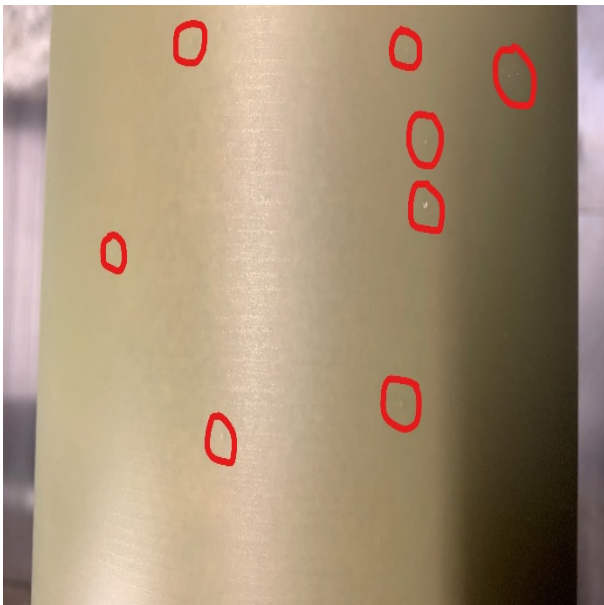
We got a delivery of a load of E300 wire guides last week which would have been from the new tooling and process etc, unfortunately our operator started skimming one of them this morning and it's full of bubbles

We will continue to review and update where necessary but wanted to inform you as soon as possible.

Pictures attached from 1 wire guide, he had to take quite a bit off before getting me to have a look and some bubbles you can see are on the surface and some are still deep into the PU so this guide will be deemed scrap at our end.

Best regards

Michelle



Customer email complaint regarding rejected rollers due to the polyurethane roller cover containing small air bubble entrapment. CMP have supplied this company with re-bonded rollers since 2005. The process involves bonding TDI/MbOCA cured polyurethane to free issue mild steel roller centres. The polyurethane grade specified on the drawing is L167 / MbOCA cured the rollers are cast oversize on diameter and proof turned. The end user then fine grinds the surface of the polyurethane roller cover which must be 100% free of any air bubbles or inclusions.

We cast 5 of a batch using Ethacure 300 an alternative to MbOCA which resulted in rejects due to small air bubble entrapment, the rest of the batch cured with MbOCA were to the required quality standard.

Rollers pictured below cast in 3 component MDI/1-4 Butane Diol cured. Rejected due to small amounts of moisture contamination. MDI being very sensitive to small amounts of airborne moisture especially the chain extender 1-4 butane diol which is very hydroscopic.



Remedial Action

Rollers stripped of defective polyurethane covers and re-cast in TDI/MbOCA formulation.

Section 4: PROCESSING

Pot life is the main driver of any system to permit casting of good quality parts.

As soon as the prepolymer and curative/chain extender are brought together to be mixed the pot-life starts. It is essential to thoroughly mix all components of any polyurethane formulation to obtain a homogenous mixture, this part of the process uses a proportion of the available pot-life, if this process is not performed correctly cast parts will be rejected due to wet bad mix patches on the surface of cast parts plus a reduction in physical properties.

Higher risk if mixing is performed manually on a bench mixer, taking longer to mix and reducing available pot-life time, not so much of an issue if mixed by the dynamic mixer on a proprietary automated dispenser. It should be noted that TDI/MbOCA cured formulations are far easier to mix due to the low viscosity of the raw materials when compared to MDI systems, especially the higher viscosity polyester versions.

MbOCA mixes very easily with low viscosity TDI prepolymers, practically self-mixing, requires little help to obtain a homogeneous mixture, only mixing 2 components rather than 3 using an MDI quasi system.

Whichever polyurethane system used the mixing time forms part of the available pot life. (Time before viscosity increases) reducing available time to pour the mixture into mould cavities.

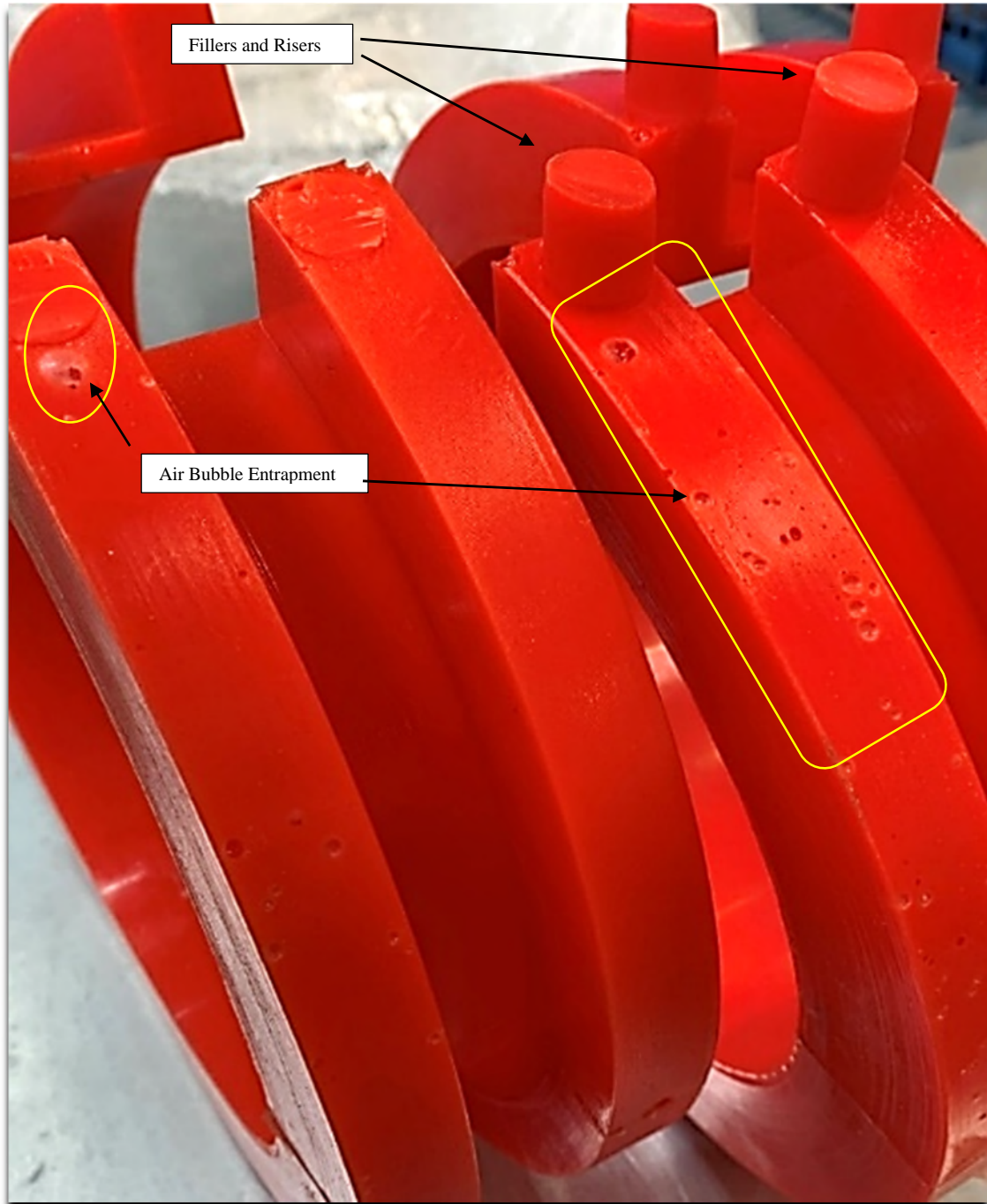
TDI/MbOCA cured system offer a major advantage having a long pot life plus a slow increase in the mixtures viscosity and low exothermic reaction temperature, giving time to pour and flood all areas of a mould tool, plus enough time for air bubbles to rise through the liquid mixture up and out of the casting into an overpour part of the casting, to be later machined away during finishings operations.

Casting of some mould tools requires pouring through small diameter filling tubes,

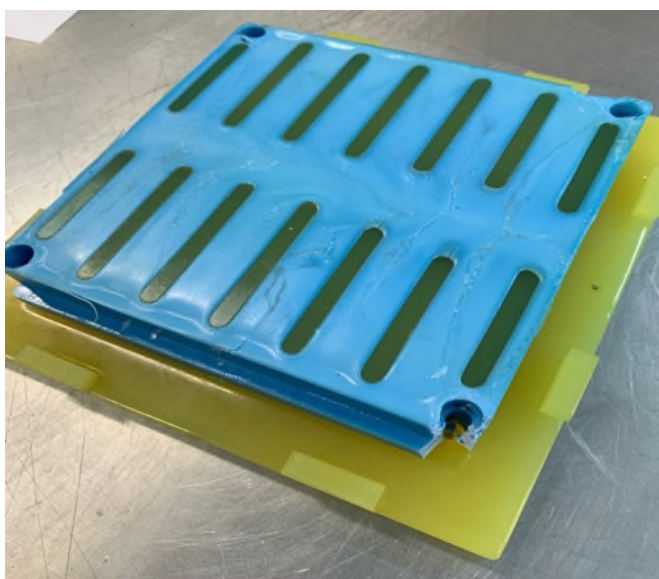
(Example part pictured below) or into narrow cavities, a long pot life, plus slow increase in viscosity of the mix is essential, pot life needs to be longer than the time it takes to totally flood any mould cavity the larger the part the more pot life required.

Pouring must be done slowly to prevent introducing turbulence which will introduce air bubbles into the mix being poured into the mould. If the pot life is too short and the increase in viscosity too quick, it is impossible to cast some parts especially in enclosed mould tools having risers and filler entry and exit ports.

Example pictured below show, air bubbles which have become entrapped in the cured part due to rapid increases in viscosity of the mixture, which is starting to cure, bubbles unable to rise through the curing polyurethane into the riser stem which is later removed in finishing operations.



Rejected part cast in 3 component MDI



Good part cast in TDI/MbOCA



Parts pictured above are component parts of a large piece of equipment used in a dirty water treatment plant. Part on the right being a good example cast in TDI/MbOCA cured, easy to cast and de-mould, no excessive shrinkage, no defects of any nature.

Part on the left cast in 3 component MDI pigmented blue at the same hardness, rejected due to being slightly off ratio highlighted by the cracking of the part the excessive shrinkage caused this part to bond to the polyurethane upstands within the casting mould tool.

2,000 parts required for a new design / development project, we need to use TDI/MbOCA cured systems to make this job efficiently in terms of both cost and processability.

TDI/MbOCA cured systems typically require shorter curing/post-curing times than alternative curatives, along with lower post cure temperatures reducing energy consumption and processing costs helping CMP to offer parts to customers at competitive prices.

Polyurethane casting companies have been processing TDI/MbOCA systems successfully for several decades to produce a vast variety of products in a vast number of industrial sectors.

TDI/MbOCA systems have gained a strong customer confidence due to its excellent durability and technical performance. As a result of this long and proven success, end-users have little, if any motivation to switch to alternative systems.

There is a vast quantity of existing parts in service which specify TDI/MbOCA grades as stated on part drawings, being the only **“approved grade”** to be used.

CMP are the only approved supplier for multiple components used in a large launch and recovery vehicle used for emergency lifesaving equipment. CMP initially worked with the design engineers during the design and development of the first vehicle, alternative polyurethane grades were evaluated for the wheels and rollers during the design and development stage which failed to meet all technical requirements.

CMP supply all the wheels and rollers for this vehicle which has a life expectancy of 50 years, therefore a spares requirement for an equivalent period. Approved polyurethane grade TDI/MbOCA cured @ 95 shore A hardness.

25 vehicles have been built since the first one was commissioned and signed off, there has never been any wheels/rollers failures reported during the many years CMP have supplied this company, giving testament to the tough durable qualities of TDI/MbOCA cured polyurethane.

There are future schedules to build 5 more vehicles making a total of 30 operating in the UK all of which, will all require spare parts due to normal wear and tear for the next 50 years plus cast in TDI/MbOCA cured PU.

CMP supply a vast array of parts cast in TDI/MbOCA cured polyurethane to a large company who manufacture fire engine ladders and associated lifesaving equipment, extensive testing was performed many years ago to identify the most suitable polyurethane grade for this tough working environment, TDI/ MbOCA cured being the approved grade selected, outperforming any alternatives.

Fire fighters require very robust, tough polyurethane components due to the abuse the parts receive whilst attending an emergency call out, saving lives, they cannot risk any parts failing causing delays, parts must work without fail. TDI/MbOCA cured polyurethane provide this reassurance.

Components cast in TDI/MbOCA systems have a longer service life than alternatives. This is an important property which end-users have become accustomed to for decades. Alternatives would result in the end user having to purchase replacements on a more frequent basis increasing their costs and downtime, this would result in a negative economic impact for CMP leading to job losses.

Due to the excellent processability of the TDI/MOCA system, it has a very low reject rate, reducing the amount of waste generated, therefore less impact on the environment plus lower expensive waste disposal costs.

TDI/MbOCA systems are also processed at lower temperatures in terms of raw materials, mould temperatures and post curing temperatures, thus reducing power consumption costs thus reducing environmental impacts.

CMP has purchased a 3-component dispenser to process 3-component Quasi systems which are basically MDI/1-4 Butane Diol cured systems. Whilst these systems are alternatives to MbOCA-based systems for some cast polyurethane products **they are not considered to be technically suitable alternatives for the full range of MbOCA-based systems**, as they have more 'general purpose' physical properties.

MDI raw materials have a short shelf life when compared to TDI/MbOCA cured systems.

MDI raw materials have a maximum of 4-months shelf life, this only applies to full unopened drums, once the seal is broken on a drum there is a very high risk that the contents will

become contaminated with very small amounts of moisture from atmosphere rendering the remaining material in the drum defective, as any moisture contamination cannot be removed.

The isocyanate component of the MDI system must be stored at elevated temperatures min of 25 °C whilst in storage adding to the processing costs.

If heated storage is not available for the isocyanate, crystallization can occur which can be reversed by heating to 80°C overnight, however if the isocyanate reaches freezing point it will suffer with dimerization which cannot be reversed.

The now defective material must be safely disposed of by special waste companies adding to the cost of using MDI systems as an alternative, both expensive raw material losses plus the high costs of safe disposal costs.

In comparison drums of TDI prepolymers and MbOCA do not have any special storage requirements, no heated storage required, their shelf life is infinite, drums of TDI prepolymers over 2 years old have been processed without any issues.

TDI/MbOCA cured polyurethane has a very long track record of very successful use. It has gained strong customer confidence due to its excellent durability and technical performances while its price is very competitive. It is therefore no surprise that polyurethane processors along with their customers prefer the guaranteed quality of this system. It is specified on many component drawings as the only grade to be supplied. Alternative polyurethane systems are typically more expensive to purchase and process.

Whilst there are some alternative grades at a comparative kilo cost, such as **MDI PPG** grades they have a much lower tensile strength. Newly developed alternative polyurethane curatives are relatively untested therefore do not have the long track record of MbOCA.

Any transition would, require our customers to take a risk, which would incur them costs in production downtime and repairs. Without MbOCA CMP would be in a situation of informing its customers of price increases for their repeat orders of existing MbOCA cured parts, cast in more expensive alternatives. **There is nothing in it for our customers**, why should they be forced to change, there is absolutely no incentive for them to do so.

The best alternatives available at comparative raw material costs are PTMEG quasi-MDI grades which have lower tensile strength and processing issues especially regarding bonding parts to metal components such as forklift wheels and rollers etc. CMP would be inundated with “in house rejects” as a result of trying to process MDI grades in place of TDI MbOCA cured grades, dramatically increasing costs, reducing profit margins, and incurring additional costs regarding special waste disposal impacting on the environment.

This situation would force our customers to look outside the UK for the supply of MbOCA cured parts putting the employment of our process operators at risk. Not an easy task in terms of logistics, costs, import duties, import procedures plus the real killer **very long lead times**, especially when UK customers have a breakdown situation and require parts urgently.

CMP offer an expedited service to satisfy this occurrence. If MbOCA use is restricted in the EU as well as the UK then MbOCA cured parts would have to be sourced from China, America, or Australia etc. This situation puts polyurethane processors such as CMP in a very vulnerable situation, along with the vast array of end user businesses who require continuation of supply of MbOCA cured parts as a matter of urgency. There will be no issue

for them to import cast parts cured with MbOCA due to the excess of prepolymer in formulations ensuring all MbOCA content of a mixture is consumed in the reaction resulting in the free MbOCA-content of fully cured polyurethane components being well below 0.1 % w/w.(weight by weight)

An alternative “**drop-in replacement**” is required if PU processors in the UK are to remain competitive, both in terms of product performance, price and processability.

Unfortunately, such an alternative is not currently available.

There is an ongoing requirement for the vast number of existing parts which were initially designed and developed using MbOCA as the **only approved curative** since it was first used as a polyurethane curative way back in 1954, specified on drawings as the **only approved grade** of polyurethane to be used.

Should TDI/MbOCA cured components cease to be manufactured in the UK, this will have a major impact on UK industry as a whole.

End users will be faced with an almost impossible task of sourcing their MbOCA cured components from overseas outside the EEA the low orders volume and logistics will be a nightmare, very long lead times will hurt them most.

Orders we process have a maximum lead time of 2 weeks, end users need this service, especially when they have manual handling equipment such as forklift truck etc. in a breakdown situation awaiting replacement wheels, or shotblasting equipment on stop etc.

The demise of MbOCA processing in the UK will have huge knock-on implications for UK industry as a whole, not just its polyurethane processors. Large high cost MbOCA cured parts will be purchased from outside the UK detrimental to the UK economy.

CMP has recently been made aware of a larger polyurethane processor who is currently struggling to manufacture existing TDI/MbOCA cured parts using alternatives. Some of their process operators have approached the MD of CMP to enquire if CMP have any job vacancies, due to their concerns that their existing employer has decided not to apply for authorisation for continued use of MbOCA. The MD asked why they were not applying for authorisation; reply was its due to their lack of understanding regarding the importance of this vital curative.

This event was closely followed by one of their genuinely concerned customers visiting our works to obtain a continued supply of his TDI/MbOCA cure tyred wheels. The wheels have been used for 20 years plus, always cast in TDI/MbOCA cured polyurethane, he has tried alternative polyurethane systems which he informed us “just don’t work.”

The above is a prime example of MbOCA being a very versatile curative which has been widely used for decades, in all industry sectors. Existing alternatives simply do not perform as well.

Many existing polyurethane parts supplied for many years to the MOD are specified to be cast in TDI grades of polyurethane, it is hoped that the manufacture of these parts, plus others will continue to be manufactured in the UK subject to processors being granted authorisation for continued use until a “drop in” alternative is commercially available.

CMP have received an order to manufacture 17,000 rollers in TDI/MbOCA cured polyurethane. This being another historical “spare part” component were the only approved, tried, and evaluated polyurethane grade as stated on the component drawing is TDI/ MbOCA cured polyurethane @ 95 shore A hardness, the end user is London Underground.

CMP is requesting a review period of 8 years or until such time that suppliers develop a suitable MbOCA free “drop in” replacement curative to match that of MbOCA, in terms of all round technical performance, processability, pot-life and cost. The time scale for this event is unknown however it is anticipated to take many years to develop.

CMP has been and will continue to work closely with all its raw material suppliers, Covestro, Coim, Notedome, Era Chemtura (Lanxess) evaluating any new systems they develop and claim to be able to match the processability and cost of existing MbOCA cured systems.

3 Component MDI -1-4 Butane Diol

Alternatives have been considered and analysed for many years at CMP, MDI systems in the main, for which CMP purchased a 3-component Baule dispenser.

MDI systems offer good physical properties and are comparative on cost, however they have many processing issues.

Slight variations in ratios can have a dramatic impact on the polyurethane's mechanical and dynamic properties the crosslinker used for this system is 1-4 butane diol which is very hygroscopic resulting in processing issues and rejects.

Very recent events have resulted in MDI grades becoming more costly to process. Due to the Crosslinker 1-4 butane diol used in mix formulations being placed in schedule 1 on the controlled substance register, to come into force on the 15th of June 2022.

Any processor is legally required to apply for a licence and pay the application fee, which is not insignificant @ £3,655 to permit continued use of this chemical.

If a licence is granted it is only valid for 1 year when a new application will be required, resulting in an ongoing increase in processing costs in terms of application fees and increased site security and processing procedures.

The strength of the PU material at the beginning of the curing process is known as green strength. Using MDI-systems, the green strength is much lower increasing the risk of the freshly cast parts cracking MDI grades also suffer with excessive shrinkage due to their high exothermic temperatures during the crosslinking stage. 1-4 Butane Diol is very hygroscopic and requires special precautions to be taken during handling to avoid the ingress of small amounts of airborne moisture. Moisture contamination will result in the formation of air bubbles in the cast parts.

CMP have invited their raw material suppliers over past years to use their production equipment to allow suppliers to process their new systems in a working production environment. As mentioned earlier, lab testing results regarding pot-life, demould times, process temperatures of small batch sizes, do not always follow through to larger scale production in terms of processability. To date no “drop-in” replacement has been identified

which suits TDI/MbOCA cured products. CMP will continue to closely collaborate with its suppliers and continue to test any new formulations as and when they become available.

A leading expert in the polyurethane industry has commented

No perfect “drop in” diamine replacement for MbOCA exists. All the substitutes are more expensive, don’t perform as well, or both. The leading alternatives are dimethylthiotoluenediamine (DMTDA) and 4,4’-methylenebis(3-chloro-2,6-diethylaniline) (MCDEA) both of which are far more difficult to process.

For decades, MbOCA has been the standard curative for toluene diisocyanate (TDI)-based polyurethane elastomers. To make them, chemical companies react TDI with a polyol, commonly polytetramethylene ether glycol (PTMEG), yielding what is called a prepolymer. Companies that fashion finished elastomeric parts mix the prepolymer with MOCA. It reacts with the isocyanate, linking the polymer strands together and curing the polyurethane.

Experts also agree that TDI and MbOCA have had “a beneficial relationship” since they were first combined in the 1950s. MbOCA doesn’t react too quickly with the prepolymer, allowing for good “pot life” and ease of processing. It is forgiving of variations in the amount mixed, meaning users don’t have to be terribly precise when metering it out. Polyurethanes represent a specialized corner of the wider elastomer’s world. Within the polyurethane elastomer world, MbOCA-cured TDI brings distinct characteristics along with its ability to adjust hardness, from soft grades as low as 60 shore A increasing in 5 degree points up to “tenpin bowling ball” hardness being 85 shore D.

The industry is exploring two main strategies for MbOCA substitution. One is to find another aromatic diamine curative to work with TDI-based prepolymers. Another is to reinvent the formula entirely and come up with new polyurethane elastomers based on MDI as, yet this has not been achieved. No replacement is commercially available to match the ease of processing, price, and all-round performance of MbOCA.

Another leading expert in the polyurethane industry has commented

“Companies have been switching from MbOCA /TDI to MDI-based systems since the 1980s, [REDACTED] says. But he knows why some firms haven’t changed yet: MDI systems are considered more difficult to work with than TDI prepolymers. MDI formulations are more sensitive to moisture, and the ingredients need to be measured with greater precision. Furthermore, MDI reacts more exothermically than TDI, making the fabrication of large parts challenging. Switching to MDI can entail spending on equipment to handle the more delicate chemistry.” Some companies wouldn’t take the plunge into MDI were it not for the regulatory push, [REDACTED] acknowledges.

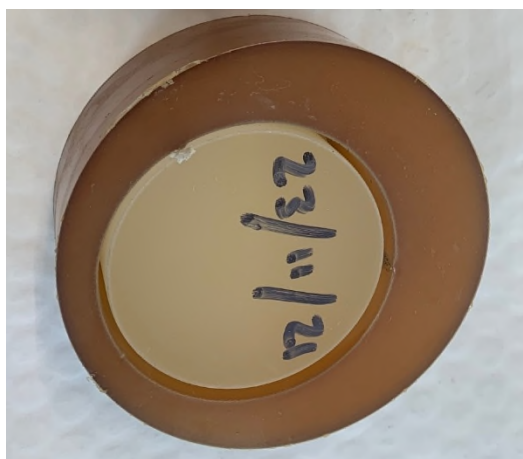
DMTDA (Ethacure 300) costs approximately 1.6 times more than MbOCA. Its physical properties are close to that of MbOCA, however there are issues with processing and finished cast components.

High heat build-up in dynamic parts such as roller coaster wheels, forklift wheels, fettling wheels, piledriver sound damping blocks etc. causing premature failure of the polyurethane. Strong sulphur odour is emitted during processing/casting which is later emitted from cast cured parts.

Some cast parts cracks appeared during the de-moulding process, due to low green strength, these were reduced by adjustments to casting process temperatures for both raw materials and moulds. However not eliminated.

Physical properties in general are lower when compared with MbOCA cured polyurethane. Abrasion resistance is lower resulting in customers having to place orders on a more frequent basis which they will not tolerate when they have enjoyed the cost saving advantages of purchasing MbOCA cured components with a long service life. Whilst this alternative is suited to less demanding applications it is not suitable for cast parts in very demanding applications.

Another major issue using DMTDA is UV resistance please see below picture of an unpigmented cast block using this curative. The centre was cut out of the block and stored in a dark place protected from UV. The outer part stored outside. The colour change is dramatic following a **short period of only 60 days** totally unacceptable to end users who require parts pigmented to a specific RAL number.



Parts pigmented black change to dark green when subjected to UV light. If parts pigmented black do not have a good UV resistance, then there is no hope for lighter colours such as yellow, light blue, red retaining their colour as cast or indeed customer specified RAL colours.

CMP is aware of a polyurethane processor who supplied traffic segregation street bollards, cast using DMTDA pigmented black, following these bollards being installed the customer complained that the bollards had turned green, each bollard needed to be painted black in situ by hand.

During the casting of DMTDA there is a strong sulphuric odour is emitted, very unpleasant for process operators. This odour continues to be emitted from cast / cured finished parts, totally unacceptable to end users.

DMTDA is 1.6 times more expensive than MbOCA, this is not just in terms of its purchase price as a raw material, it is further increased by the high level of rejected parts during processing. Green strength is low at the point of de-moulding cast parts, resulting in parts cracking

These increased costs cannot be passed onto customers, who justifiably expect to be supplied with parts having the same physical properties at the same cost as MbOCA cured parts.

CMP as a processor would be forced to absorb these additional costs, reducing profit margins. In addition, DMTDA does not offer any benefit regarding impact to the environment, it is no better than any risk issues MbOCA represents.

MCDEA manufactured by the Swiss fine chemical's maker Lonza. Physical properties are more in line with MOCA, in some cases even better in terms of its dynamic properties, however costs 6 times that of MbOCA and has an extremely short pot life making it almost impossible to process, only suitable for small components such as skateboard wheels etc.

The short pot life is also detrimental to obtaining good bond strengths to metallic parts such as wheel centres or backing plates and bonded inserts.

Once again **Pot-life** is the biggest issue with this alternative rendering it almost impossible to use. Average **pot-life** with a typical TDI/MbOCA cured system @ 95 shore A hardness is 4-5 minutes when MbOCA is replaced with M-CDEA pot-life is dramatically reduced to less than 1 minute making it impossible to fill moulds over 100 grams in cast weight.

Moulds need to have large open areas to allow the mix to be poured into the mould very quickly, before viscosity increases and the mix cures to a solid. Many of our existing parts cast in TDI / MbOCA have thin sections, some parts cast in closed mould tools having risers and fillers, these moulds require a long pot-life to allow the liquid mixture to flood all areas of the mould tool.

HQEE (HYDROQUINONE BIS (2-HYDROXYETHYL) ETHER is considerably more expensive than MbOCA, Chemtura (now Lanxess) developed this system, claiming it to be a "drop-in replacement" for TDI/MbOCA, in reality this is not the case. switching from TDI/MOCA to an MDI-system, such as LF-MDI/HQEE, will significantly increase raw material costs, making CMP uncompetitive in the marketplace, it also has processing issues regarding crystallisation, LF-MDI/HQEE is difficult to process VIBRACURE® 2101 crystallises very easily.

Extract From Processing Data.

Note: Do not loosen the pail or drum to relieve the pressure. This will allow moisture into the prepolymer which can damage the material.

Being an MDI system. it is also very moisture sensitive. It is only supplied as a 2-component single hardness system, we currently process TDI/MbOCA cured systems through a 3-component dispenser permitting a versatile system with a hardness range from 60 shore A up to 95 shore A in 5 hardness point increments.

The prepolymer has low tolerance to being heated to process temperatures whilst being processed, not an issue if casting large parts where heated materials in the dispenser is used

over a short period, however when casting small parts, as we do at CMP this would present an issue as the prepolymer would be de-graded in heated machine holding tanks prior to it all being processed.

Extract From Processing Data.

Heat Stability

The NCO content of ADIPRENE® LF MDI prepolymers decreases with time upon exposure to heat. Prolonged heat exposure will result in lower than expected final hardness and physical properties of the cured elastomer and longer demold times. Maximum recommended heating times as a function of temperature are shown below.

Temperature Duration

70°C (158°F) 3 Days

85°C (176°F) 24 Hours

100°C (212°F) 8 Hours

Drums of raw materials have a short shelf life (4 months) as opposed to TDI /MbOCA prepolymers which have very long shelf life, excess stock, due to inaccurate material requirement forecasting will result in expensive safe disposal of drums of expensive, “shelf-life” expired materials.

Heated storage is required for the isocyanate component, as with other MDI based raw materials, adding to the processing costs. Both process and post cure temperatures are higher than MbOCA cured systems, resulting in higher power consumption costs.

Extract from tech data for this system

Mold Temperature °C (°F) 100-120 (212-248)

Post Cure Conditions Hours / °C (°F) 16 / 100-120 (212-248)

TDI prepolymers are processed @ 70°C and post cured @ 80°C less power consumption required.

One of the biggest issues processing HQEE is due to VIBRACURE® 2101 being very temperature sensitive, it quickly crystallises inside heated hoses and metering pumps if the processing temperature slightly drops below its melting point 99°causing “off ratio” mix resulting in rejected parts. This system also requires the addition of an expensive catalyst addition to control pot life and de-mould times.

There is no polyurethane dispensing machine commercially available which has the required precise temperature control to process this material, especially during winter months when LEV pulls in cold air across exposed lagged heated hoses, mix heads and recycle valves.

This issue raises health and safety concerns as a blocked heated delivery hose, from a high-pressure metering pump to the mix head on any dispenser, could result in a high-pressure release if a heated hose bursts potentially releasing the hot chemical.

In order to process this alternative system, CMP would need to purchase a new dispenser at an estimated cost in excess of £150,000. The dispenser would need to be modified in an

attempt to remove any chance of the isocyanate being able to crystallise, have high temperature storage tanks, high output gear pumps, customised heated hoses, heated mix head, even then the crystallisation of the VIBRACURE® 2101 may still present issues regarding processing and health and safety.

Extract From Processing Data.

VIBRACURE® curatives listed in the data tables must be processed above their melting temperatures (>120°C) to ensure that process lines, pumps and valves do not block.

CMP has taken measures over the past 4 years to convert as many components as practically possible from TDI to MDI to reduce the amount of MbOCA processed.

New production equipment was purchased to facilitate this.

Polyurethane grades tend to be customer and end use application driven. Due to the fact MbOCA has a very long track record of being the best all-round polyurethane grade, it is well known within the industry and end users.

SECTION 5: SUMMARY OF AOA

The table on the following page is a summary of alternatives evaluated. It clearly demonstrates that MbOCA is by far the superior choice regarding ease of processing achieving the highest score when compared to any of the alternatives evaluated.

TDI / MBOCA	MDI 1 - 4 Butane Diol	MDI / HQEE.	DMTDA (Ethacure 300)	MCDEA	AOA Summary of systems used 3 = Good 2= Medium 1= Poor Higher score denotes a more suitable alternative
3	2	2	2	1	Long pot-life
1	3	3	2	3	Lower health risk
3	2	3	2	3	Very good physical properties
3	1	1	3	2	Low processing temperatures
3	1	1	2	2	Easy reliable processing
3	1	3	3	3	Requires licence (controlled substance)
3	1	1	3	1	Requires exact stoichiometry (ratio control)
3	1	1	3	1	Requires dedicated disperser
3	1	1	2	1	Good green strength on de-moulding
3	1	1	3	3	Issues with moisture control
3	1	1	3	3	Requires addition of expensive catalyst
3	1	2	3	2	Low temperature exothermic reaction
3	1	2	3	2	Rapid increase in viscosity issues casting intricate parts
3	1	1	3	1	Can be used with Ester & Ether prepolymer
3	2	1	2	1	High raw material cost
3	1	1	3	1	Gradual / slow increase in viscosity of mix
3	1	1	3	1	Heated storage required for raw materials
3	1	1	2	2	Long shelf-life raw materials
3	2	3	2	3	High tensile strength
3	2	2	2	2	Very good all-round performance of cast parts
3	1	1	3	2	Good bond strengths, wheel & tyre applications etc.
3	3	1	3	2	Easy to change hardness of PU parts
3	2	1	3	3	Quick melting re drums of prepolymer
3	2	1	2	1	Long track record resulting in end user confidence
3	1	1	2	1	Easy to process by hand mixing or dispenser
3	1	1	2	1	Easy to hand mix small quantities
3	3	3	1	1	Strong Processing odours
3	3	3	1	1	Good UV light resistance
82	43	44	68	50	

The lion share of our product range requires TDI/MbOCA grades due to the end use application where high performance is required in terms of all round high tensile strength in a wide variety of applications.

- Shot blasting machines
- Large forklift wheels
- Steel coil support pads for steel works
- Scraper blades
- Wire saw rollers and pulleys
- Pile driving sound damping blocks
- Ceramic pressing membranes
- Fire engine ladder rollers and components
- Lifeboat recovery vehicle rollers
- Flexible road traffic bollards
- High load bearing crane wheels
- Lifesaving equipment
- Theme Park wheels and rollers.

MDI is more suited more general components where high tensile strength is not required or bonding to metallic parts such as wheel centres or back plates, due to MDI having very high exothermic reaction temperatures resulting in poor metal to PU bond strengths.

MbOCA was first used as a polyurethane curative in 1954 during the 68 years it has been used, there has obviously been a vast number of polyurethane parts designed and developed utilising MbOCA, many of which are still in service some parts being smaller integral, process critical, components of much larger pieces of equipment with an ongoing requirement for spares.

Raw material suppliers have over the years developed non-MbOCA systems, unfortunately none of them currently available can match the all-round, high-end performance of MbOCA cured systems which is much easier to process, offering low reject levels, lower processing power consumption, longer shelf life for raw materials, no raw material heated storage required etc.

There is nothing to be gained for customers to try alternatives when they have parts which have performed very well in service for a multitude of years, they will adopt the attitude of “why try to fix something which is not broken” combine this with asking them to pay more for their parts. It just will not work resulting in lost business, threatening UK employment for UK based polyurethane processors plus causing big supply issue to UK based end users who require spare parts.

If the MbOCA use situation was a worldwide issue, then all processors would be on a level playing field in terms of what they could offer, regarding performance and price, therefore safeguarding polyurethane processors and jobs within the UK.

Hopefully, there will be a “drop in alternative” available in the future to match the performance, price and processability of MbOCA.

The demand for MbOCA cured parts is customer driven, therefore if the UK is unable to supply, customers will be forced to source their parts from outside the EEA where there is no restriction regarding processing MbOCA.

This situation poses a very real threat to all UK based polyurethane processors and end users resulting in possible business closures.

TDI/MbOCA systems are very versatile offering a good range of hardness's by blending the prepolymers available, therefore it is easy to select a formulation / hardness to tailor mix formulations to suit end use applications in terms of hardness, tensile strength, heat resistance, cut resistance, tear resistance, compression set, resilience, abrasion resistance, hydrolysis resistance, oil resistance and elongation at break.

TDI/MbOCA systems are easy to process both by hand mixing, where small mix quantities are required of any special hardness grades, also by dispensing machines where larger castings are required.

Unlike other alternative systems mix ratios of TDI/MbOCA do not have to be exact +/-3% off ratio will still produce good quality, high tensile strength polyurethane.

The process temperatures of moulds and TDI prepolymers plus post curing temperatures are lower than alternatives offering lower processing costs.

The viscosity is low for both TDI prepolymers and MbOCA resulting in easier processing by hand mixing or through dispensers. **Pot-life** of the mix is long, with no rapid steep rise in viscosity, easy to cast large items such as the rollers pictured below being 25 kilos each, taking 6 minutes to fill the mould which would not be possible with most alternatives as their **pot-life** is too short, being less than the time required to completely fill the mould, resulting in voids. The first cast mix into the mould starts to cure whilst the mould is still being poured, the fresh low viscosity mixture still being poured fails to fill undercuts created by the curing mix in the base of the mould, creating voids and visible join lines between the part cured mix in the base of the mould and the fresh cast material higher up the part. The casting process needs to maintain a "wet on wet" state throughout the time required to completely fill the mould, the whole cast part then cures as one mass.

25 kilo Rollers cast in TDI/MbOCA cured polyurethane @ 95 shore A hardness



TDI/MbOCA polyurethane systems are for very demanding applications. Unfortunately, there is currently **“no drop-in replacement”** for MbOCA in terms of processability or physical properties and all-round performance.

The author of this report would like to state, that he **does not wish** to process a chemical which is classified R45 risk, suspect **human carcinogen** (bladder cancer).

Due to there currently being no **“drop-in replacement”** for MbOCA as detailed in this report, CMP considers it has no other option, than to seek permission for its continued use in order to safeguard the employment of its employees and ongoing customer requirements.

CMP considers that the requirement for MbOCA cured polyurethane parts, out way the low risks to health associated with the **safe handling** of MbOCA.

The author of this report requests that consideration is given to the impact placed on both processors and end users of polyurethane components in the UK. In the event of no MbOCA cured polyurethane components being available from UK or EEA processors.

This event would have a **major impact** on the vast number of UK based end users, who have an ongoing requirement for long established MbOCA cured spare parts.

Low volume order quantities for parts, plus logistics issues since Brexit, will present end users with a massive problem trying to source outside the EEA extending lead times and costs.

CMP was formed in 2004 with the intention of focusing on the design and development of high-performance polyurethane components, MbOCA being the vital ingredient in achieving this goal.

During the 18 years trading CMP has achieved its goal and continues to develop new parts, where possible trying to make use non-MbOCA alternatives in the first instance, moving onto MbOCA if alternatives fall short of the end user's specifications in terms of all round performance.

As a result, CMP has a long-established large product range of MbOCA cured products, our customers have ongoing spares requirements through repeat orders for these parts.

Although several alternatives to MbOCA have been developed and are available for use in the production of hot cast polyurethane, many issues exist regarding their use. Processing with these alternatives involves significant changes in processing, equipment, along with expensive catalysts in attempts to extend pot life. The resulting products differ in performance characteristics and increase production costs.

CMP is in the process of developing a new product range of flexible bollards which will only be possible if MbOCA is available due to its high tensile strength especially tear strength and excellent memory / recovery of these tubular bollards. MbOCA is the vital ingredient here, allowing them to be driven over, flat to the ground and recover to an upright position minus any evidence of damage.

Alternative systems have been evaluated which fall short of the required performance.

Significant investment has already been made regarding R&D resource and production equipment; without MbOCA this capital investment will be written off, along with the prospect of employing additional process operators to manufacture high potential sales volumes of this pending new product.

SECTION 6: ECONOMIC IMPACT

As mentioned previously in the application report, CMP was founded primarily based on manufacturing and supplying high performance, high tensile strength, hot cast polyurethane components to most sectors of UK industry. Polyurethane is a very versatile material used in a vast amount of remarkably diverse applications.

Over its 18 years of trading the business has established a vast array of MbOCA cured components, most having repeat orders, as a result MbOCA cured components make up **85%** of the company's turnover.

Without the availability of MbOCA the company will be crippled

CMP has considered its options in the event of **not being granted** authorisation for the continued use of MbOCA, as below: -

- 1. Relocation of the business outside of the EEA.**
- 2. Stop offering MbOCA cured parts, attempt to use more expensive alternatives.**
- 3. Downsize the business to 15% of existing sales of non-MbOCA components**
- 4. Total closure of the business**

Option 1

Not realistic, would not happen.

Option 2

Would be very difficult and costly, trying to process parts in alternative non-MbOCA grades, suffering the very high level / costs of in-house rejects and raw materials, high costs of special waste disposal of cast rejected parts plus out of shelf-life raw materials. Trying to get customers to accept parts of a lower performance than previously supplied and asking them to pay more! reducing customer confidence and loss of orders.

Lots of existing parts are specified as TDI/MbOCA grades which **cannot be changed**.

Where higher prices cannot be passed on to customers for more expensive alternatives the business would have to absorb the additional raw material and processing costs further decreasing profit margins. This would result in loss of sales, sadly resulting in job losses of long serving resolute employees.

Option 3:

Reduce the workforce by 75% downsize the business, only supplying the 15% of current sales of existing non-MbOCA parts, trying to build this to a level to allow the business to survive, still having to pay its fixed overheads such as rates and service charges etc.

In practice this option would be a very difficult to achieve due to reasons explained in this application report, we have tried to move as many parts as possible away from MbOCA in the past without success, nothing has changed to make this option work, customers need TDI/MbOCA cured parts which they will have to purchase outside the UK.

Option 4

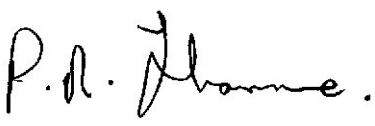
Last resort would result in closure of the business and loss of 9 full time jobs.

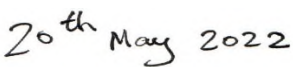
CMP would welcome being granted authorisation for continued use of MbOCA, until such time as a suitable alternative is commercially available comparable regarding processability, performance and cost.

SECTION 7: DECLARATION

The applicant is aware of the fact that evidence might be requested by the Health and Safety Executive to support 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 (20th May 2022) 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: 

Date, Place: 
GLOUCESTERSHIRE U.K.