How to raise manhole and inspection covers safely

The problem with stuck and seized covers with no recognised best practice in industry

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Executive Summary

Many industries need to raise manhole and inspection covers, both in the UK and internationally. These covers come in all shapes, sizes, materials, and weights. The pick holes or keyholes which can be used for lifting keys also vary by function and region. In the past, manual workers were left to their own devices when it comes to accessing the important stuff below the cover. Shifting stuck and stubborn covers was incidental and subject to less scrutiny – this is no longer the case as the health and safety of workers is of significant importance for employers. However, the sheer mass, variety and longevity of covers means practice in lifting them varies by function, region, and industry.

It does not have to be like this. Methodology based on sound physics and established manual handling techniques means that it is time to set the best practice using the correct tools for the job, potentially minimising injury, maximising effectiveness and not wasting time on indeterminate attempts to loosen stubborn covers, which may involve actions which are not as safe.

The CoverUp Key uses a combination of sound design, mechanical technology, and optimum material selection to achieve a safe, effective, and efficient way to release stubborn and stuck manhole or inspection covers. This, in turn can empower and help ensure the safety of your workforce, through the adoption of a safe system of work. UK health and safety legislation requires employers to make sure, so far as is reasonably practicable, the H&S of employees and anyone else who may be affected by a work activity is not compromised. This is commonly referred to as the ‘duty of care’. The legislation requires employers to fulfil their ‘duty of care’ responsibilities by reducing risks to as low a level as is reasonably practicable

Introduction

This whitepaper is not about lifting heavy weights – there are many tools and methods for that job which each have their pros and cons. Manual handling is well documented and the subject of how to move a manhole or inspection cover when it has been freed is adequately managed outside the scope of this paper, however there may remain an element of manual handling within the activity of freeing an inspection cover.

Moreover, equipment used to lift loads is subject to UK and EU regulation; [i] this whitepaper will differentiate between the separate problems of releasing a stuck or seized cover and the process of removing it from the manhole/inspection chamber.

Perusal of equipment provided to gain access to manholes and inspection chambers by suppliers in the water/drainage/utilities/telecoms/pest control/safety industries will readily yield a variety of approaches and similar types of equipment which it is assumed are for addressing the problem of getting manhole and inspection covers off the surrounding frames which hold them securely in place. Careful analysis of these methodologies will reveal that they rely on the same physics to generate a constant and large lifting force which will be sufficient to lift (and sometimes release) the covers. This does not address the fundamental problem of stuck or seized covers and in many cases conflates the problem of releasing a cover with that of safely lifting and moving a heavy cover.

Extensive experience in the aforementioned industries by way of personal interviews, industry knowledge and years of exhibiting at trade shows and supplier open days reveal repeated themes. When manual operatives are asked what they do when they encounter a stuck or seized cover, the following responses are generally encountered:

- No answer – “I’m not going to tell you because what I do is not approved and could be regarded as risky”
- Manual tools approach – manhole lifting key, hammer and chisel, crowbar, wrecking bar
- When the manual tools approach has failed, use the heavier duty tools available: lifting key with lever, Bottle cap seal breaker, hydraulic lifter
- Lifting key(s) attached to a telehandler or backhoe

Rarely, if ever, is a response forthcoming where the company approved approach and method is both effective and accepted by the workforce. This whitepaper will explore the problems with the methods extant in industry as well as demonstrating how a unified approach can deal with risk and efficacy in a cost-efficient way using CoverUp keys as part of the solution and safe system of work.

Problem Statement

The problem with stuck and seized manhole and inspection covers is by design – covers are designed to stay in place and bear a load without rattling. The material with which they are fabricated ensures that they do not deform and that they are robust enough to function for decades in hostile environments. Typically, stuck and seized covers will be held in place by grit, corrosion and compressed fit in the rim. Additional complicating factors may include subsequent maintenance where painting, road surfacing and construction work have added material which inadvertently has further secured the cover in place, making manual removal more challenging.

The situation can be easily visualised by thinking about a wooden door which is stuck closed against its wooden doorframe because of swelling, the friction between the door frame and the door is preventing it being opened. Faced with a very stuck door, one question should be asked: What sort of force should be applied to effectively release it? Apply increasing amounts of force slowly or apply repeated impact? The answer should be obvious – Releasing a door which is stuck by friction by hammering it open is more effective than pushing on the door with increasing force. Similar principles are involved when driving a nail into a surface – we use a hammer to apply impact force in the correct direction, we don't try to push a nail into place.

We can analyse current practice by breaking it down into broad categories which reflect the severity of the 'stuckness' of the cover:

Cleaning and water

Initially, the dirt and grime which can be seen and accessed by a chisel and/or screwdriver can be cleared away by scraping the edges of the cover. Additionally, water can be poured around the same edge and time allowed for it to penetrate and loosen material causing the friction.

This can be sufficient to free some covers allowing the seal to be broken using lifting keys.

Pros:

- Standard tool sets
- Relatively quick if successful
- Not much training/instruction is required to give people sufficient skills to do this safely.

Cons:

- Bending to ground level is required, providing for uptake of a posture presenting ergonomic risks

- The operative also must judge whether the force they are applying to release the cover with the lifting key is more than can safely be done with good posture
- There is an elevated risk of back/manual handling and other injury if the cover is not unstuck easily.
- Failure to unstick the cover has cost time

Hand tools alone

After initial attempts have been made, increasing measures of physical effort are often introduced to persuade the cover to 'rock' and break the seal: wedging and vibration techniques are employed. A lump hammer and chisel can be employed around the edges of a cover, and the chisel used as a lever to try and obtain purchase in moving the cover laterally – sometime pry holes or slots are provided for the purpose and a prybar or crowbar can be used. When this is unsuccessful, a sledgehammer can be applied liberally around the frame or lid to introduce vibration which may loosen grit and grime. However, a sledgehammer is not a precision tool, and the force is being applied in the opposite direction than is needed to effect a solution. Another tool which can be used at this stage is a wrecking bar – this is generally used as a combination of heavier duty chisel with the backing of a sledgehammer weight. As the mass of these tools increases, so does the risk of injury to the worker/colleagues, or to the cover/frame requiring remedial attention or replacement.

This methodology carries higher levels of risk as increasing force is applied manually, but in the wrong direction as far as releasing the cover is concerned – downward or sideways, as opposed to upward.

Pros:

- Standard tool sets
- Sometimes achieves success when persevered with

Cons:

- Inefficient – these methods don't apply the required force in the correct direction
- Risk of damage to the cover and frame, costing time and money to repair retrospectively
- Health and safety risks associated with using hammer and chisel, sledgehammers, crowbars, pry bars or wrecking bars – the operator is constantly judging whether to apply more manual force and whether to injure themselves when doing so
- Failure to unstick has cost more time

Specialist lifting tools

There is a subset of specialist tools which work in a variety of ways to achieve the same effect – increasing upward force applied to the cover. This can be via the cover pick or key holes, or directly to the cover with the use of large magnets.

Some of the methods used by these devices are levers around a pivot in conjunction with a bottle jack, manually applied levers using mechanical advantage and the weight of a person at the long end of the lever, hydraulic pumps with mechanical linkage to raise a frame. The force that can be applied using these devices can range in the region of over 1.5 tonnes of constant vertical force.

Often it is recommended to apply the vertical force generated by these devices gradually while applying vibration to the cover and frame with a hammer. By increasing the force and hitting downward with a hammer, more stubborn covers can be released.

This method is not always effective, and due to the way that the force is applied, this can sometimes raise the frame along with the cover, requiring a repair or replacement as a result.

Pros:

- More effective for stubborn covers than initial manual methods
- Does not require manual brute strength
- Depending on the tool, it can be used to safely lift heavy covers after the seal has been broken

Cons:

- Equipment is specialist
- Training will be required to operate the lifting machinery safely
- It takes more time to retrieve and set up the equipment
- Bending to ground level is usually required providing for uptake of a poor posture presenting ergonomic risks
- It can lift the frame with the cover if it is stuck fast
- The equipment is designed to lift heavy weights, not break a seal
- Equipment can be expensive and requires periodic thorough examination and inspection by a competent person for SWL under requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Specialist manhole lever tools

Some manholes are designed to be opened using specially designed lever tools. The design of the manhole allows for a lever tool to be inserted right at the edge of the manhole and an upward force applied with a long-handled lever tool. The underside of the lever hole is stepped toward the inside of the cover allowing for upward force to be generated by the correct tool. Two examples of manholes typical of this design from Norway are shown below:

Fig 1. Two Norwegian examples of manholes designed to be opened with a specialist lever tool

Examples of the types of tool designed to be use with these types and designs of manholes is shown below:

Fig 2. Examples of specialist lever tool

It can be seen by the design of the tool that:

1. The aperture of the manhole must be designed to engage with the tool i.e. a simple pry hole or slot is not the same – the combination for the tool and manhole design allows for upward force to be applied by the tool, not sideways force.

2. The mechanical advantage provided by this type of tool is large, approximately 80kg of manpower force applied to one end of the lever could produce approximately 1 tonne of constant vertical force.

Whilst this is a large force generated from an averagely able human, it is still a constant force, rather than an impact force. The tool will likely deal with most covers which are stuck or seized to some degree. However, the principle remains that upward impact force would be more effective at releasing a stuck or seized cover.

Pros:

- More effective for stubborn covers than initial manual methods
- Does not require such manual brute strength due to efficiencies of lever mechanical advantage
- Depending on the design and weight of the cover, it may be used to safely drag the cover when it has been freed

Cons:

- Can only be used for covers which have been designed to be opened with the tool
- Will not be effective for covers which are severely stuck or seized

It should be noted that these specialist lever tools are not the same as magnetic or lever-based lifting tools as illustrated below – the mechanical advantage offered by the tools shown in Fig 3. is far less than those shown in Fig 2. due to relative distance of the lifting end from the pivot the tool in Fig 2. has a mechanical advantage of approx. 12:1 whereas the tools shown in Fig 3. have mechanical advantages in the range of approximately 1.5-4:1, so they do not even generate the same constant upward force.

Fig 3. Examples of lever-based specialist lifting tools

The purpose of this review of current methods and practice is to illustrate that the most effective method of releasing a stuck cover is not provided by them. A constant force in this situation will not be as effective or efficient as an impact force in the correct direction.

Solution Overview

The CoverUp Key, currently branded as ManUp Key in the Americas, was designed to administer a significant impact force from the underside of a manhole or inspection cover. Intended to be used on cast, or ductile cast iron covers, it takes advantage of the average strength capabilities of a fit person, while providing ergonomics which enable the operator to maintain a safer working position during usage. i.e. the operator can use the tool in an upright position without unnecessarily bending/twisting and administer a significant impact to loosen the cover within a safe system of work

'More than a third of all accidents reported across Highways England's projects each year are associated with manual handling' and 'Excessive stress and strain causing injury to muscles and tendons, particularly where handling involves bending, twisting or other difficult postures are one of the main hazards' [ii]

The Health and Safety Executive also recognise that in construction activities 'The combination of awkward postures and continuous handling can contribute to discomfort and a risk of injury' [iii] and also 'Musculoskeletal disorders accounted for around a third of all cases of self-reported work-related ill health to workers in Great Britain in 2023/24' under Reporting of Injuries Diseases and Dangerous Occurrences Regulations 2013. [iv]

What does relevant health and safety legislation require? 'The Management of Health and Safety at Work Regulations 1999 require employers to assess the risks to the health and safety of your workers. Where this identifies hazardous manual handling of loads, you should also comply with the Manual Handling Operations Regulations 1992. The Manual Handling Regulations set out a clear hierarchy of measures employers must follow to prevent and manage the risks from hazardous manual handling:

- avoid hazardous manual handling operations, 'so far as reasonably practicable'
- assess the risk of injury to workers from any hazardous manual handling that can't be avoided
- reduce the risk of injury to workers from hazardous manual handling to as low as reasonably practicable. [v]

According to HSE Guidance [vi] Upper limb disorders also may be caused by lifting covers especially 'due to uncomfortable or awkward working postures and/or use of sustained or excessive force'. The Guidance also outlines that where risks cannot be eliminated employers are required to 'make sure tools and equipment fit the workers' hands and are suitable for the task' and change the workstation layout to improve the posture of the workers, particularly when they are applying force, reduce the amount of force, vibration, repetition, and prolonged fixed postures, reduce the length of time that operators do the same task, allowing regular changes in posture

The CoverUp Key works by combining the mass of the tool, and patented slide hammer mechanics, to ensure that the maximum impact is generated to loosen covers with a manual effort. The tool is not designed to break the seal of a cover with a single blow, but rather to be used in the same manner as a hammer, releasing a stuck cover with successive blows until the cover is freed. This solution is designed for the precise problem generally faced with stuck covers; grit, grime and corrosion usually provide significant friction for a stuck cover over a distance of millimetres due to the design of fit between cover and frame. Hence the repeated impact force which can be administered by the CoverUp Key will successively loosen the cover, as opposed to trying to pull it free with a single applied force.

This design has the additional advantage that it enables operators who are not as physically able or with reduced capacity to achieve the same results with a few additional knocks.

Use of the Cover Up Key also has the advantage of meeting some of the measures listed by the Health and Safety Executive for employers in undertaking assessment of repetitive tasks of the upper limbs, [vii] in that it enables the efficiency of the application of force as well as providing for good posture of the worker

Detailed Solution

It is established fact that repeated or cyclic impact forces can help overcome static friction more effectively than a single applied force. Repeated impacts, especially in dynamic or vibrational contexts, can reduce the energy lost to friction and lower the required force to sustain movement. [viii] This phenomenon, known as dynamic loosening, has been studied in bolted joints and other mechanical systems, where continuous or repeated impacts reduce static friction resistance due to accumulated micro-movements and residual stress in the contact area. [ix]

The phenomenon where repeated impact forces can help reduce static friction more effectively than a single applied force, enabling movement, is studied in various contexts. Research by Seifried et al. and others has shown that repeated impacts between objects can increase the coefficient of restitution (COR) and the resulting force magnitude due to residual stress, which allows for progressive movement under lower frictional resistance. [x] This effect is especially pronounced when impacts induce micro-movements or oscillations that "jump" surfaces, temporarily reducing the static friction threshold required to initiate motion.

These principles are adequately illustrated in practice by noting the rise in popularity of tools such as impact drivers which employ similar underlying principles as the CoverUp key i.e. application of a repeated impact force to cumulatively overcome a dry friction force more effectively than a single force applied once.

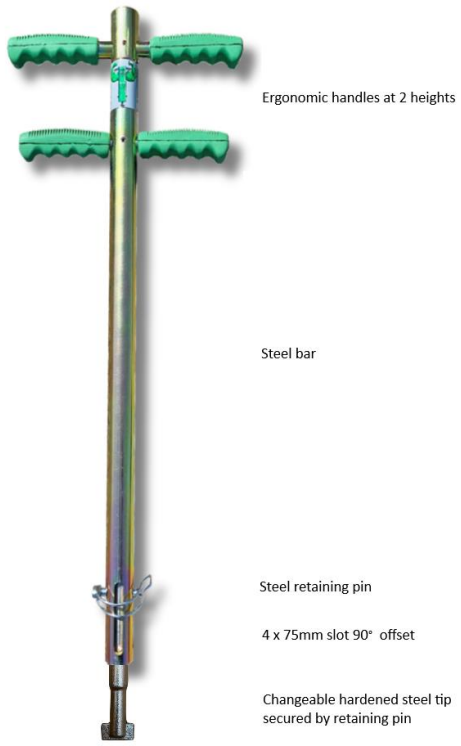

Fig 4. The component parts of a CoverUp Key

Fig 4, above, illustrates the component parts of a CoverUp key – it is a simple mechanical slide hammer where the tip (or hammer head) is designed to be interchangeable to make it a universal tool for all types of pick or keyholes used in covers. The tip shown is the most commonly used 32mm Flat tip. The Tool is engaged with the cover by the operator by fitting the correct tip in the key, locating the tip into the cover hole and twisting the key 90° so that when lifted, the upward motion causes the tip to collide with the cover. The upward impact force is generated by lifting the key quickly in a single upward motion. Other tips work in a similar way but may not engage with a keyhole e.g. 20mm Gulley tip or 16mm J Hook tip.

The patented slide hammer action provided by the 75mm slot ensures that enough upward motion can be generated with all types of covers, including covers with blind keyholes i.e. the keyhole does not go all the way through the cover.

The material used and design of the bar ensures that there is a balance between weight and usability. The impact force that can be generated using the tool is proportional to the mass and velocity of the moving object; therefore the heavier the bar, the more impact force can be generated. However, this is only practical to a point. The fully assembled CoverUp Key weighs approximately 6kg, which is heavy enough to generate significant impact force, but light enough to be carried and used by an average person without presenting significant manual handling risk.

The impact force that can be generated by the tool in the hands of an average person can be calculated as follows:

Using the Work-Energy Principle to estimate Impact Force (F):

- The work done by the impact force F to stop the hammer is equal to the initial kinetic energy. The work W is given by:

$$W=F\cdot d$$

- Setting W=KE (Kinetic Energy), we get:

$$F = \frac{\mathrm{KE}}{\mathrm{d}} = \frac{\frac{1}{2}mv_i^2}{\mathrm{d}}$$

Where:

- m is the mass = 6kg
- v_i is the initial (or impact) velocity
- d is the deformation distance

The key can be raised by an average person in approximately 0.1 seconds.

The distance the key is raised is 75mm.

Assuming a linear acceleration across the distance of travel, a final velocity can be calculated of 1.5 m/s.

The deformation distance for a rigid, hard material like cast iron or ductile cast iron can be estimated as between 0.01 – 0.05 mm (0.00001 – 0.00005 m) [xi]

Substituting for the above, we have:

$$F = \frac{\frac{1}{2}mv_i^2}{\mathrm{d}} = \frac{\frac{1}{2} \cdot 6 \cdot 1.5^2}{0.00001} = 675{,}000 \text{ Newtons} = 68{,}830 \text{ kg}$$

If we account for the estimate range of deformation distance, we calculate an impact force of between 13,766 and 68,830 kg. These figures seem intuitively too high, but the methodology and the calculations are sound. They are based on an assumed, but reasonable, deformation distance for cast iron. For this impact force to be true, there would need to be no other deformation distance of movement at the point of impact. In reality, there will be additional elastic deformation – movement of the frame and/or the ground around it or compacting material between the tip head and the cover. There will also be compaction in the tool which lessens the impact force. The movement will be very slight, maybe in the µm range, but will make a difference to the impact force delivered.

These rudimentary calculations show that a single average person with average strength can use the tool to exert the correct type of force (impact force) in the correct place (from beneath the cover) in the correct direction (upward) without the need to contort a safe working posture (upright, naturally straight back). Repeated action will determine the viability of removing the cover without damage to it or the frame.

Understanding the variables which are significant contributors to the impact force also empowers the operator to have a major impact. For example, lifting the tool faster will significantly change the impact force generated; this will obviously be limited by the physical ability of the person using the tool. Cleanness of the contact point between the tool and the strike point will also affect the impact force delivered, so these things should be addressed when instructing operators how to correctly use the tool.

It is accepted that there will be situations where the tool will not succeed in releasing the cover, sometimes they are just stuck too tight. In these cases, other lifting or freeing methods are likely to damage the cover or lift the frame with the cover. Producing test data to prove these outcomes is difficult, since there is only one opportunity to break a cover seal and the opportunities to study the outcomes only occur by happenchance. Our anecdotal data has been gathered over years where other methods have been used to try and release a cover and when there is no hope but to dig out a cover, the CoverUp key has been used and the cover has been released.

Benefits and Outcomes

The benefits of using the CoverUp Key are many and should be considered alongside the low cost of the tool.

Safe

The CoverUp key is designed for one purpose and with safety of people in mind. The key can be safely lifted upward and quickly by a person maintaining a naturally straight back adopting a good posture. Recommending that stubborn covers should be hit at their impact points using the CoverUp Key up to 10 times will give the operator a reasonable opportunity to determine whether the cover will come free at all, or whether replacement is needed. The 2 heights of handles provided allow for adjustment to better suit the height of the worker, and for the lower handle to be used to lift and drag the cover clear when it is freed within manual handling limits (up to 25kg for a single person) using leg strength, rather than bending at the hip – covers can be deep, and the additional height afforded by the lower handle makes it a more versatile and ergonomically safe tool.

Companies which have taken the CoverUp key for use in their workforce have tailored their toolbox talks to ensure that adequate training in the correct use of the tool and removal of covers is consistent and adequate to satisfy the requirements of the H&S at Work etc. Act 1974. A templated Toolbox talk is available from CoverUp Key on request for customer use.

Effective

It has been demonstrated that the CoverUp Key has been designed and developed to overcome the specific physics and material properties encountered when lifting manhole and inspection covers. Our anecdotal evidence is that it is effective in 95% of cases where stubborn covers have been encountered, but this claim cannot currently be supported on paper.

Efficient

If a customer is using a traditional method for raising covers, they will iterate through various methods before releasing a stubborn cover – this takes time. If a CoverUp Key is used every time, there is no need to change tools when a stubborn cover is encountered and hence no lost opportunity cost. We recommend that anyone who may need to raise a stubborn cover carries a CoverUp key with the standard kit of tools. After an initial assessment of the cover, using the CoverUp Key is no more cumbersome or time consuming than using a standard lifting key.

If a customer only needs the CoverUp key once, the cost of purchasing the tool will have been recouped in lost labour and opportunity cost.

Standardisation

There are economies of scale in training and equipping workforces with a single methodology. Provided it is proven as effective and efficient, the benefits scale across the whole business. The benefits provided by using the CoverUp Key as the tool to use when raising covers will potentially reduce back/manual handling injuries caused by raising manhole covers (again we only have anecdotal evidence to back this up), will require fewer dig-outs for covers which have been broken or can't be removed, and will enable the workforce to get on with the job more quickly. The purpose of raising the cover is to get to whatever is beyond, so raising the cover is not generally the point of the exercise.

The CoverUp Key is usually bought with a kit of tip selections appropriate to the region and industry e.g. UK drainage, US Drainage, UK Telecoms, etc. Additional tips can also be bought for other applications if they are needed. The tips are stored with the bar in a single and robust carry case, making it suitable for global territories and sectors. The tips are easily interchangeable by the operator via the sprung retaining clip, and they are designed and intended to last a long time. However, they are replaceable parts (like chisels or hammers) and can be purchased separately.

Use cases

There are currently 15 different interchangeable tips (including cleaning tips for silted key holes) available for the CoverUp Key, and 1 variant of the CoverUp Key bar; this indicates the versatility of the tool. As a responsive company, keen to bring the advantage of the tool to as many situations as possible we also prototype, then produce new tips as and when new applications are discovered by customers.

Tips are bundled together in common collections to address specific sectors and geographies. [xii] Currently bundled sets include the following:

- (UK) Drainage
- (UK) Telecoms
- (UK) Electricity
- (UK) Pest Control
- (UK) Fresh Water
- (UK) Gas Network
- US (Drainage)
- Canadian (Drainage)
- Australian/New Zealand (Drainage)
- German (Drainage)
- Japanese (Drainage)

These sets have been assembled in response to user and market demand – where a new territory is found; the customer is generally shown the full range of tips, and they collaboratively recommend the bundle which comprises the set for the territory. The UK market has been variously investigated across multiple sectors over time, hence the reason there are sets recommended for each sector, whereas overseas territories have primarily been investigated in the drainage/water/utilities sector only. This is changing as the full commercial potential of the tool is being realised.

Fig 2. Current Full set of CoverUp Key Tips

Fire & Rescue Service

The variant to the bar which is also available was designed in collaboration with the UK Fire & Rescue Service. Many of the UK Fire & Rescue Services equip their fire appliances with the Fire Hydrant CoverUp Key. This configuration of tool uses the same principle as the ordinary CoverUp Key but is designed to be usable with a vertical handle which can be reconfigured horizontally for use with a hydrant valve tool. These features were designed to provide the perfect balance between safety, effectiveness, and speed. Space and weight are also optimised so that the tool takes up minimum space and weight on the vehicle. When the previously used tools were replaced by the Fire Hydrant CoverUp Key set, the overall weight carried was reduced. The tool carries 2 additional required tips incorporated into slots in the bar so there is no need to carry separate parts.

Fig 2. Fire Hydrant CoverUp Key in various configurations

Conclusion

There is no longer any need for significant risk to be presented in connection with workers attempting to raising heavy and stuck manhole covers, inspection covers, or gulley grids and covers using ad-hoc or unapproved methods. With a combination of properly defined procedure, the CoverUp key, interchangeable tips, and equipment for moving heavy lids, proper risk assessments and safe working practices can be assembled to satisfy every company's needs.

Add to this the benefits of industry best practice, the efficacy of the solution and the efficiencies afforded by this approach, there is a win-win-win situation:

- A method of releasing stuck covers, tailored to each company and industry, providing for workers' safety in hazardous environments
- A higher likelihood of cover removal without damage or need for replacement
- A cost-effective method of gaining access where it is needed without delay and avoiding losing out due to the opportunity cost

While this issue is not effectively addressed by many companies, the opportunity for you to take positive, decisive action is here. The CoverUp Key is available from many resellers, nationally and internationally [xiii] – let us know if you are unable to find a reseller that you can use, and we will fix it.

Begin the transformation of this part of your business here – don't delay, it is costing you.

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