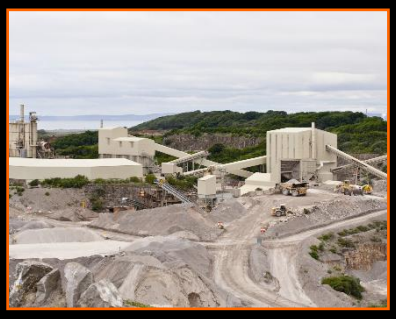





White Paper:

Achieving Hot Bitumen Safety

HYCONTROL
LEVEL MEASUREMENT SOLUTIONS

Hot Bitumen Safety – Still an Issue, Ten Years On

Despite clear industry guidelines published a decade ago and revised in 2015, ***Hycontrol*** *still regularly encounter asphalt plants with insufficient safety protocols for preventing spills of hot bitumen.*

Introduction – Bitumen Storage in the UK

Recently-issued information from **Eurobitume** (the European Bitumen Association) has reinforced the need for stringent safety precautions on sites with bitumen storage facilities – key amongst them being the implementation of a robust level monitoring and alarm system (**'Site Inspection for the Delivery of Bitumen'**, Eurobitume UK, June 2015).

There are over 300 asphalt manufacturing plants in the United Kingdom, with a total of approximately 1300 bitumen storage tanks. Bitumen is pressure-delivered hot (up to 230°C) and must be stored at a constant high temperature (ranging from 125-190°C depending on the grade and type of product). As a result, spillages from these tanks as a result of overfilling have a high potential for serious injury (*as pictured right*).

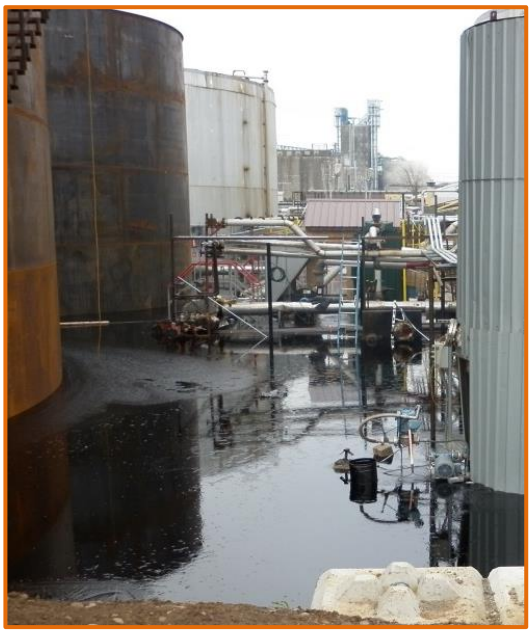
Whilst the risks associated with the storage of hot bitumen have been known for decades, it is only comparatively recently that strong, clear guidelines for the handling of this dangerous and difficult substance have been published. In the face of year-on-year increases in injuries and incidents at sites across the UK (peaking at 82 spills in 2003), the **Refined Bitumen Association** (RBA) first published concise guidelines for safe bitumen tank management in October 2004. The RBA is a consortium of major oil companies and bitumen producers including Shell, BP, ExxonMobil and Nynas. The document, entitled **'Guidance for Safe Bitumen Tank Management'**, lays out key causal factors in spills:

- Ignorance of tank dimensions and capacity
- Unsuitable and unreliable measurement instrumentation
- Poor communication on sites

Evidence shows that spills typically occur from a combination of these factors, which in themselves would not necessarily cause a spillage.

The guide goes on to outline the technology required to overcome these issues, the need for changes in staff attitude and training together with the need for clear communication. In the decade since this key document was issued there has been a sharp decline in the number of spillage events. The recent Eurobitume document has served to reinforce and underline the ongoing importance of the original RBA document.

However, Hycontrol have clear evidence that there are still a sizable minority of sites making do with unreliable bitumen level control equipment, poor tank content information and outdated safety systems. These factors present a highly dangerous environment, potentially putting plant personnel and drivers at risk of receiving life changing or even fatal injuries.



David Wadsworth, UK Sales Manager for level measurement experts Hycontrol is clear on the dangers this presents: “Frankly it is remarkable that, ten years on from the RBA’s definitive statement on bitumen level monitoring and safety, we are still seeing bitumen storage facilities that are making do with totally outdated technology to monitor a potentially lethal substance. Plumb-bob and ‘cat-and-mouse’ pulley-based systems are still common, despite their propensity to jam or wear out. All too often these devices are also expected to double as a High Level Alarm (HLA), or else another inappropriate technology like a rotary paddle switch is used to fulfil this function. Again, devices like this are prone to wearing out and becoming blocked up with sticky bitumen – and when they do fail what will then stop the tank from overspilling?”

“What’s also clear from our site visits is that the lack of clearly-displayed tank contents information continues to be a major safety issue,” continues Wadsworth. “Site operators may have a vague idea of the product volume they think a storage tank can take, but more often than not they haven’t considered the parts of the tank that are unavailable to fill, or the need for a defined safety margin at the top of the tank. This situation is compounded if the tank is not empty and the level measuring equipment is inaccurate. In this situation operators may have a false idea of how much bitumen they can safely receive. Meanwhile tanker drivers will know the quantity of product they are carrying, for example in litres – but crucially they may have no idea how that converts to the capacity available in the vessel they are blowing product into!”

It is also worth noting that if the site does not have a weighbridge, then the amount of delivered bitumen may have to be converted from litres into tonnes, presenting another chance for errors to arise.

Causes of Spills

There are three main factors that can contribute to the cause of bitumen overfill events and in many cases a spillage can result from a combination of some or all of these:

- Ignorance of, or confusion about, tank capacity
- Poor safety equipment – suitability, maintenance and calibration
- Lack of staff training

It is believed that at least 90% of bitumen accidents can be attributed to the simple problem of drivers and site staff not understanding the 'true' available tank capacity – i.e. the actual amount of storage space available for the bitumen product being delivered. Whilst a vessel may be declared to have a certain capacity, there will always be a certain space at the bottom of the tank below the draw-off point which will never be drained, and so must be discounted. Similarly (and though it seems obvious it is frequently not considered) it would not be possible to fill the tank above the overfill pipe – reaching and exceeding that level will result in a spill. Despite this the unavailable space above the overfill point is still included in the vessel's nominal capacity.

Therefore it is a vitally important safety issue that staff be aware of the difference between a tank's declared capacity and its actual safe working capacity (which is itself 90% of the available tank capacity). In parallel, it is vitally important that staff have an accurate measurement of the actual tank contents at the time of delivery (the tank may not be at its lowest point).

Consider the following example of a newly-installed bitumen tank with a stated capacity of 100 tonnes:

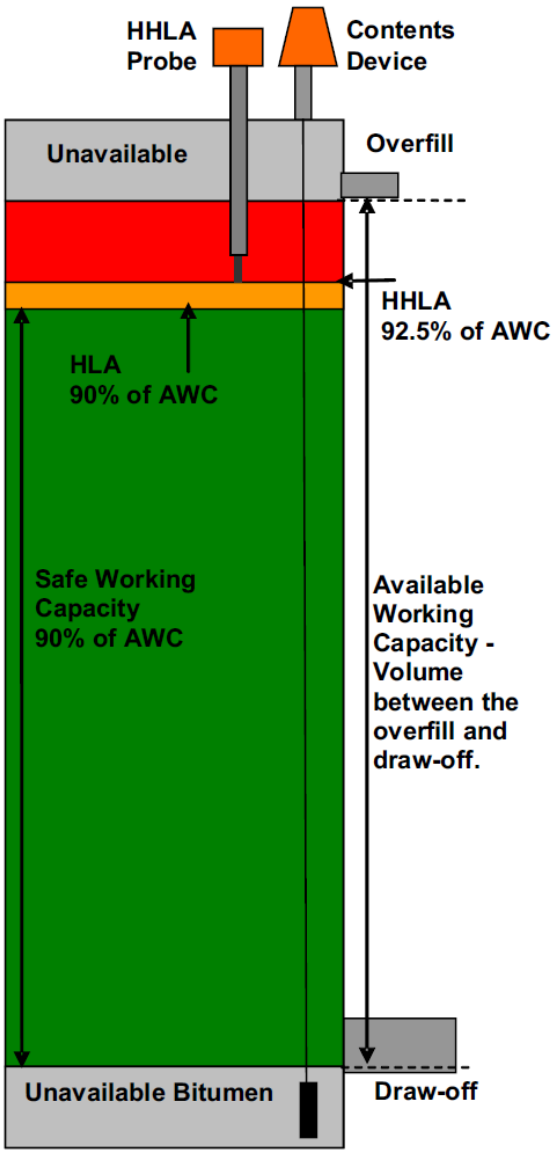
Nominal Tank Capacity [NTC]	105.8 m^3	97.3 tonnes
Unavailable Tank Capacity (top and bottom) [UTC]	5.3 m^3 + 1.0 m^3 = 6.3 m^3	5.8 tonnes
Available Working Capacity [AWC = NTC – UTC]	99.5 m^3	91.5 tonnes
Safe Working Capacity [SWC = AWC x 0.9]	89.6 m^3	82.4 tonnes

Therefore of a stated capacity of 100 tonnes, only 82.4 tonnes can safely be stored. It is little wonder then that misunderstandings of capacity are commonplace, and are the leading cause of bitumen spillages.

The simple fact is that there is a total lack of uniformity and consistency across the asphalt industry when it comes to storage and contents information. In cases where level measurement and alarm equipment is unsuitable or out-dated, the problem is only compounded. The high-temperature, viscous characteristics of bitumen can easily cause unsuitable equipment to fail or operate erratically. Also, if members of site staff are not correctly trained, then even the most advanced technology will prove ineffective. All of these issues must be addressed in order to achieve a satisfactory solution.

A Combined Solution – Accurate Level Measurement

Having been consulted by the RBA throughout the compiling of their guidelines, Hycontrol are better placed than most to point out shortcomings in bitumen level safety at sites they visit. With over thirty years of experience as an innovator in the level measurement field, the vital first step that Hycontrol advise is that sites ensure they have a 'belt and braces' approach to tank security. Indeed the RBA guidelines agree, stating that not only should all bitumen tanks be fitted with a reliable contents gauge that can trigger a HLA at 90% available tank capacity, but they also require a separate High High Level Alarm (HHLA) that is completely independent of the contents gauge and which will trigger at 92.5% available capacity. Only by doing this can site managers and staff begin to be truly confident of their ability to accurately judge tank contents and to avoid overfilling. The illustration to the right shows a typical 'good' tank set-up.



The next important step is to choose suitable technologies for the level gauge and the HHLA. Whatever is chosen will need to withstand exposure to an extremely nasty, high-temperature, sticky product that coats everything it comes into contact with or that is exposed to its carbonising vapours. There are many measuring principles that have been

claimed to be suitable for use on bitumen but in reality few can continue to operate when they are coated – most fail or give false readings and alarms. After extensive field tests of ultrasonics, radar, floats and capacitance probes, Hycontrol now recommend TDR technology (Time Domain Reflectometry, sometimes erroneously referred to as 'Radar on a Rope') for bitumen level measurement and the HLA.

TDR technology, originally used to detect breaks in subsea communication cables, uses pulses of low power microwaves sent along the conducting probes. In a typical bitumen application, the stainless steel probes of the TDR sensor are fitted to flanges at the top of the tanks and extend down into the hot bitumen. The probes allow a very narrow measuring profile up to a maximum range of 24 metres and this is particularly useful for measurements in tanks which have internal structural supports.

At the point where the microwaves meets the air-bitumen interface, they are reflected by the bitumen back along the probe. The measured time between emission and reception back at the sensor head is proportional to the distance. This information is then converted to the level in the tank and a 4-20 milliamp signal, proportional to level or ullage space, is then fed to the displays in the external panel.

The advantage of this technology, which enables it to overcome the coating issue inherent in bitumen tanks, is that microwaves travel virtually at the speed of light and pass over any coating on the cable with negligible effect. Hycontrol have seen examples where a TDR cable has still operated reliably with a carbonised coating along virtually its entire length. Periodic cleaning is recommended as part of a site maintenance schedule in order to prevent the coating becoming too thick, but this need only be a couple of times a year. Performance is also not affected by changes in pressure, temperature, dielectric constant or viscosity, making TDR the perfect solution for hot bitumen.

Pictured: High-temperature Hycontrol TDR probe and RF Admittance switch in a bitumen application

A Combined Solution – An Independent Alarm

As previously discussed, RBA recommendations state the High High Level Alarm switch must be independent of the continuous level monitoring gauge. It will also need to be equally resilient to the build-up of product on the sensing element. Float switches and similar technologies will inevitably fail due to product build up and maintenance is an expensive issue.

Hycontrol's extensive site experience has shown that RF Admittance probes best suit the HHLA requirement as product build-up on the sensor does not impede its function. A protective insulation electrode between the conventional main electrode and the grounding sleeve allows the electronics to distinguish between coating and the actual product level. Again, whilst periodic cleaning is still recommended, utilisation of the correct equipment will have the added benefit of a vastly reduced maintenance requirement compared with old-fashioned measuring equipment. Admittance probes have no moving parts and so are not prone to wearing out like mechanical devices.

A Combined Solution – Testing Vital Components before Each and Every Fill

It is best practice (and indeed common sense) for both the HLA and HHLA to be tested before each and every fill. As it is not practical or safe to have operators climbing to the top of tanks prior to a delivery to test these alarms, Hycontrol provide a Ground Level Test facility as standard. This significantly benefits site Health and Safety by eliminating the need for operators to climb tanks. The simple one-button test process takes only a few seconds to check the functionality of critical measuring equipment. Only when all equipment has been tested and verified can the filling process be started.

A Combined Solution – Clear Displays and Clear Understanding

Finally, the Refined Bitumen Association guidance is clear on the need for visible, unambiguous display information for drivers and site staff. Panels should have very clear indication of the alarms and their status, along with flashing beacons and loud sirens to alert users when an alarm level is reached. This is vital to ensure tank integrity is maintained. In response to this requirement Hycontrol

manufacture a wide range of alarm and test panel solutions with easy-to-see level indicators for single and multi-point sites, all adhering to the RBA's recommendations. These can include displays of contents, ullage and tank temperature and have the option to integrate an independent alarm via a separate power supply to the panel.

Professional and Competent Installation and On-Going Maintenance

However as we have seen previously the correct equipment is only the first part of the bitumen safety puzzle. The equipment must be correctly installed and commissioned, which is in itself a job for experienced, specialist engineers. The bitumen tank environment is very harsh, and regular maintenance will be required to keep instrumentation clean and functional. It is also important that equipment calibration is checked and corrected to ensure that the accuracy of level readings is maintained. Hycontrol ensure continuity of service by having teams of trained specialist engineers available to visit sites on a regular basis.

Conclusion

As the both the RBA and Hycontrol conclude, 100% bitumen safety is an achievable end, but it is a multi-faceted issue that requires successful implementation of a number of factors including:

- Accurate and reliable contents measurement, with unambiguous presentation of salient information.
- The correct calculation of ullage using tank contents information to determine whether there is sufficient room in the tank to allow a new load to be delivered without overfilling.
- Effective communication between plant personnel and bitumen tank drivers, together with strict adherence to operating procedures.
- The provision of suitable safeguards to warn of an impending overfill condition should something go wrong.
- Participation and commitment from both drivers and site personnel during the delivery and offloading process.

In summary, David Wadsworth concludes: “It is clear that despite the progress that has been made over the last decade, there is still some way to go in terms of educating site managers, H&S officers and staff of the risks associated with bitumen storage. Only through a combination of appropriate, well-maintained monitoring equipment and alert, informed site staff can we be confident in the safety of bitumen storage equipment. This will continue to be a challenge as long as there are asphalt plants that persist in a lackadaisical, ‘it will do’ attitude. We are determined to work towards achieving complete bitumen safety in the UK.”

Appendix: About Hycontrol

Hycontrol have been at the forefront of level measurement technology for over thirty years, providing effective pressure, level and flow solutions for customers in the quarrying/aggregate, food, water, waste, beverage, chemical and environmental industries. Based in Redditch, Worcestershire, the company has been trusted to oversee thousands of applications across the UK and around the world. The company mission is to provide a 'complete solution' service to customers. With the experience and skill to design, manufacture, install and maintain bespoke measurement and control systems that are crafted to suit the particular needs of each individual customer, the goal is simple: to provide the best engineered solution - without compromise.

For more information visit ***www.hycontrol.com***

sales@hycontrol.com / +44 (0) 1527 406800

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Hycontrol UK (Head Office)
Orchard Street
Redditch
Worcestershire
England
B98 7DP
Tel: +44 (0) 1527 406800
Fax: +44 (0)1527 406810
Email: sales@hycontrol.com
Web: www.hycontrol.com

Hycontrol China
Room N601 Peking Times Square
Hui Zhong Li
Chao Yang District
Beijing 100101
China
Tel: +86 108 487 1101
Fax: +86 108 487 1033
Email: simon@hycontrol.com.cn
Web: www.hycontrol.com.cn

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