IP RESEARCH REPORT

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FOREWORD

The investigation detailed in this report was commissioned by the Energy Institute's Distribution and Marketing Committee, to provide terminal operators with information on the ability of a range of instruments to meet specific operational requirements.

The investigation also involved field trials (of one type of instrument which was considered to be closest to meeting the desired operation requirements) and compared data from that instrument with those from instruments in current use.

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EXECUTIVE SUMMARY

This report describes the results of an investigation into the validity of using instruments to monitor carbon monoxide (CO) in the vent emissions from gasoline Vapour Recovery Units (VRUs), as a means of detecting carbon bed hot spots. The report considers whether there is evidence to support use of CO measurements in principle, and evaluates the types of instrument that could be used. The work is primarily based on the experience of petroleum distribution terminal operators, VRU manufacturers and service organisations. This is supplemented by information from carbon suppliers and the manufacturers of CO monitoring instruments, particularly those instruments which have been used in this application. The key findings of this investigation are as follows:

— It is generally recognised that there may be some CO evolved in VRU carbon beds during normal operation, and that increased CO emissions are likely to result from carbon bed hot spots.

— There is no clear consensus amongst carbon suppliers, VRU manufacturers and operators over the likely CO concentration in the VRU vent, compared with the background atmospheric concentration, which is typically under 10 parts per million (ppm). The limited quantitative evidence available indicates that the CO concentration in normal operation may reach a few tens of ppm. It is considered feasible that the concentration may be several hundred ppm in the event of a hot spot, although no supporting evidence has been obtained in practice.

— One factor which makes it difficult to quantify the likely CO concentration in the vent is that this will be related both to the rate of CO evolution (governed by the hot spot size and intensity) and to the vapour flow rate through the carbon bed. A hot spot in an off-line bed could result in increases in the CO concentration within the bed, but with no rise detected in the vent until vapour flow resumes.

— There are also differences in normal CO emissions between carbon types, and between VRUs with the same type of carbon, depending on factors such as the newness of the carbon, and how thoroughly it has been conditioned.

— Whilst temperature sensors within the carbon beds may be slow to respond to a hot spot unless they are close to it, they will provide information as long as they are functioning and enabled, even if the VRU is not operating. The temperature sensors should still therefore be used as the primary alarm and shutdown system.

— It is likely that the CO from a hot spot in an off-line VRU will be detected in the vent as soon as the unit is started and there is flow. This may still lead to more rapid detection than could be obtained solely by temperature monitoring. CO monitors therefore may provide useful additional information, to supplement use of the temperature sensors.

— Several years' operational experience of CO monitoring has been obtained on over 20 VRUs in

the UK. This includes use of both simple (electrochemical) and sophisticated (tuned infrared) devices. Variants of both are available with appropriate ATEX certification for hazardous area use.

— Electrochemical monitors are known to suffer from a high degree of cross-sensitivity to the other gases normally present in the VRU vent, so may give spuriously high CO readings. The effect can be reduced by use of replaceable selective filters. The cells typically require replacement after around two to three years, and the filters typically every three months. Regular calibration checks are also essential. Installation of these devices provides a limited quality of information, at relatively low cost.

— Experience with the more sophisticated tuned infrared monitors has generally been good, with relatively low levels of cross-sensitivity to other gases. These devices are also inherently more stable than the electrochemical cells. The results confirm that it is possible to measure the CO concentration in a VRU vent to reasonable accuracy, by use of these sophisticated (and relatively expensive) instruments.

— On the basis of the relatively accurate response of the infrared instrument, it is reasonable to consider its use as an alarm for VRU shutdown purposes, particularly if the normal CO concentration for that VRU is well established. An electrochemical sensor, on the other hand, is better used for advisory purposes only.

— It is confirmed that there is limited justification for installing CO monitors in VRU vents, although they can provide an aid in indicating the presence of carbon bed hot spots. Where CO monitors are installed, it is important to appreciate the limitations of their use in this application.