Guidance on managing obsolescence and upgrading industrial automation and control systems (IACS)

energy institute

GUIDANCE ON MANAGING OBSOLESCENCE AND UPGRADING INDUSTRIAL AUTOMATION AND CONTROL SYSTEMS (IACS)

First edition

February 2021

Published by
Energy Institute, London
The Energy Institute is a professional membership body incorporated by Royal Charter 2003
Registered charity number 1097899

The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 23 000 individuals working in or studying energy and 200 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the EI addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:
– the Engineering Council to award Chartered, Incorporated and Engineering Technician status, and
– the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer, and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit **http://www.energyinst.org**

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies:

ADNOC
BP Exploration Operating Co Ltd
BP Oil UK Ltd
Chevron North Sea Ltd
Chevron Products Company
Chrysaor
CLH
CNOOC
ConocoPhillips Ltd
DCC Energy
Drax Group
EDF Energy
EDPR
ENI
E. ON UK
Equinor
ExxonMobil International Ltd
Innogy
Ithaca Energy
Intertek
Kuwait Petroleum International Ltd
Neptune Energy
Ørsted
Phillips 66
Prax
Qatar Petroleum
Repsol Sinopec
RWE npower
Saudi Aramco
Scottish Power
SGS
Shell UK Oil Products Limited
Shell U.K. Exploration and Production Ltd
Siemens Gamesa Renewables
Spirit Energy
SSE
TAQA Bratani
Total E&P UK Limited
Total UK Limited
Uniper
Valero
Vattenfall
Vitol Energy
Woodside
World Fuel Services

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

ISBN 978 1 78725 228 8

Published by the Energy Institute

Hard copy and electronic access to EI and IP publications is available via our website, **https://publishing.energyinst.org**.
Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.
For more information, contact the EI Publications Team.
e: **pubs@energyinst.org**

CONTENTS

Contents continued

LIST OF FIGURES AND TABLES

Page

Figures

Tables

FOREWORD

Industrial automation and control systems (IACS) provide the operator with information and data used for status monitoring, and where applicable, controlling plant, process and equipment. These systems have been developed further to provide automatic control of these variables using different types of elements such as motors, valves and other similar devices. Aside from simple forms of measurement, such as clocks and weight that date back centuries, the common application and use of IACS has been in place since the onset of heavy industry in the early half of the 20th century. The technology used by analogue and digital control systems has evolved to such an extent that it would now seem impossible for any process to operate effectively without them.

Standards that cover IACS have arisen in order to provide a consistent approach to the techniques and accuracy of equipment used across the world. The UK, along with other countries, has also written into relevant good practice certain requirements covering IACS when they are used in high-risk processes, and none more so than the requirements for functional safety (British Standards Institute (BSI) BS EN 61511 *Functional safety – Safety instrumented systems for the process industry sector*) and equipment used in explosive atmospheres (BS EN 60079 *Explosive atmospheres. Electrical installations design, selection and erection*).

IACS, like other major plant and equipment, needs an ongoing plan of care and maintenance, not only to maintain the equipment function as designed, but also to ensure that the original intent and purpose of it (e.g. accuracy, safety, quality, and reliability) remain.

At some point, organisations will likely need to make a decision as whether to upgrade an IACS to a newer version (e.g. because the original equipment manufacturer (OEM) stops supporting the existing system, changes to software, etc.). Alternatively, the organisation may decide to maintain and manage an obsolete system until such time that it can be upgraded/replaced, or until the plant closes.

This publication is aimed at those responsible for the operation, maintenance and update of IACS, including control and instrumentation (C&I) engineers, information technology (IT) engineers, project managers and project engineers responsible for upgrades, maintenance and IT technicians, and risk management teams.

It provides guidance on two possible courses of action that owners and operators of IACS can take in order to manage their ongoing use of IACS:

- upgrade to a new IACS, or
- manage obsolescence, if an upgrade is decided against.

It also provides guidance on the factors that may influence this decision.

This publication has drawn on many existing sources from the public domain, together with input from practitioners from the power utility industry, and good practices from other high reliability industries.

The information contained in this publication is provided for general information purposes only. Whilst the Energy Institute (EI) and its contributors have applied reasonable care in developing this publication, no representations or warranties, expressed or implied, are made by the EI or any of the contributors concerning the applicability, suitability, accuracy, or completeness of the information

The EI welcomes feedback on its publications. Feedback or suggested revisions should be submitted to:

Technical Department
Energy Institute
61 New Cavendish Street
London, W1G 7AR
technical@energyinst.org

ACKNOWLEDGEMENTS

This publication was developed by Jeremy Gadd (Covol), at the request of the EI Power Utility Committee (PUC). During this work, committee members included:

Steve Gilmore (Chair)	Uniper
Edward Jamieson	RWE
Stuart King (Secretary)	Energy institute
Ian Kinnaird	Drax
Ali Kuba	Aramco Overseas
Toby Lant	Centrica
Daniel Rawdin	SSE
Doug Smart	EDF Energy

Management of the project and technical editing were carried out by Stuart King (EI).

The EI would also like to acknowledge the following organisations for their contributions to the development and review of this publication:

Chevron
EDF Energy
Health and Safety Executive
SSE

Affiliations are correct at the time of contribution.

1 INTRODUCTION

1.1 BACKGROUND

Managing and maintaining an ageing plant, and by inference obsolescence, has become a fundamental part of the engineering skill set needed in production, industry and IT environments. Its effects on plant and equipment can create financial and operating challenges that can only be resolved through initial design, forward planning and focused activity. These effects can also contribute to an increase in potentially unsafe conditions arising as a result of their ageing and obsolesce.

There are a number of publications covering the topic, including Health and Safety Executive (HSE) RR823 *Plant ageing study*, which covers a much broader scope including a section on electrical, control and instrumentation (EC&I), BS EN 62402 *Obsolescence management,* and the International Association of Oil and Gas Producers (IOGP), which has written its own guidance on obsolescence management for automation systems (Report 551 *Obsolescence and life cycle management for automation systems – Recommended practice*).

1.2 WHAT IS OBSOLESCENCE?

Obsolescence is the status arising from the combination of advances in technology, and the general ageing of plant and equipment. It can be considered as the transition from the availability of products by the original manufacturer or supplier to unavailability.

Just because equipment is 'obsolete', does not mean it is no longer used or useful. However, if not adequately considered and managed, the breakdown of obsolete equipment that leads to plant shutdown or even health, safety, security or environmental impacts becomes ever more likely. Prior to breakdown, the signs of obsolete equipment are limited availability of spares, end of support for software operating system and vendor-specific software versions, closely followed by declining technical expertise in equipment technology.

The result is equipment that can no longer be maintained and, without a plan in place to mitigate obsolescence, the plant and/or equipment can no longer operate as designed.

A strategy to manage obsolescence ('obsolescence management'), that includes the IACS, should be created early in the plant life cycle to avoid being in, or at least not being prepared for, this position.

Obsolescence management can be considered in two ways:

- An ongoing process to continually review a system's performance, check updates from the manufacturer, etc. in order to understand whether the system is at risk of become obsolete in the foreseeable future.
- The process to maintain the operation of an already obsolete system until such point as it is upgraded or the plant closes.

1.3 WHAT IS AN INDUSTRIAL AUTOMATION AND CONTROL SYSTEM?

An IACS comprises numerous pieces of equipment that can be broken down into three basic elements:

- **Measurement** (input signal) from field instrumentation, such as transmitters and other similar equipment.
- **Display, manipulate, record** (the control system) such as distributed control systems (DCS), or programmable logic controllers (PLC)/supervisory control and data acquisition (SCADA) systems.
- **Control element** (output signal) to receivers such as control valves, on-off valves and motors.

In distinguishing an IACS and a safety system, the former is installed and used to monitor and provide direct automatic control of plant and process equipment. A safety system ensures that the safety of the process operation is managed through the automatic override of control functions up to and including shutdown of the whole process.

In the context of this publication, the IACS is defined as the display, manipulate and record element of the elements listed. Section 3 provides further definition and details of the types of IACS in use.

The elements of the IACS considered in this document include:

- software;
- hardware, including human machine interface (HMI) displays, and
- security measures.

These elements, once combined into a system, take on the more well known names such as DCS, SCADA system, HMI, PLC, etc.

As cyber attacks continue to be a threat, the importance of security systems such as firewalls, antivirus software, secure logins, dedicated networks, virtual private networks (VPNs) and third-party connections has come to the fore when managing IACS, and although not central to this document, particular reference to obsolescence in respect of these systems is made.

1.4 WHAT IS THE LIFE CYCLE OF A CONTROL AND INSTRUMENTATION SYSTEM?

Once commissioned and in use, the life cycle of an IACS generally follows the recurring cycle in Figure 1. At the centre of the cycle are the means of support used to rectify the issues arising over its lifespan, and these will include technical resource (including engineers, maintenance personnel and operators), availability of parts/spares, along with the OEM's support and assistance. As levels of support decline, obsolescence will start to impart its effect on the IACS.

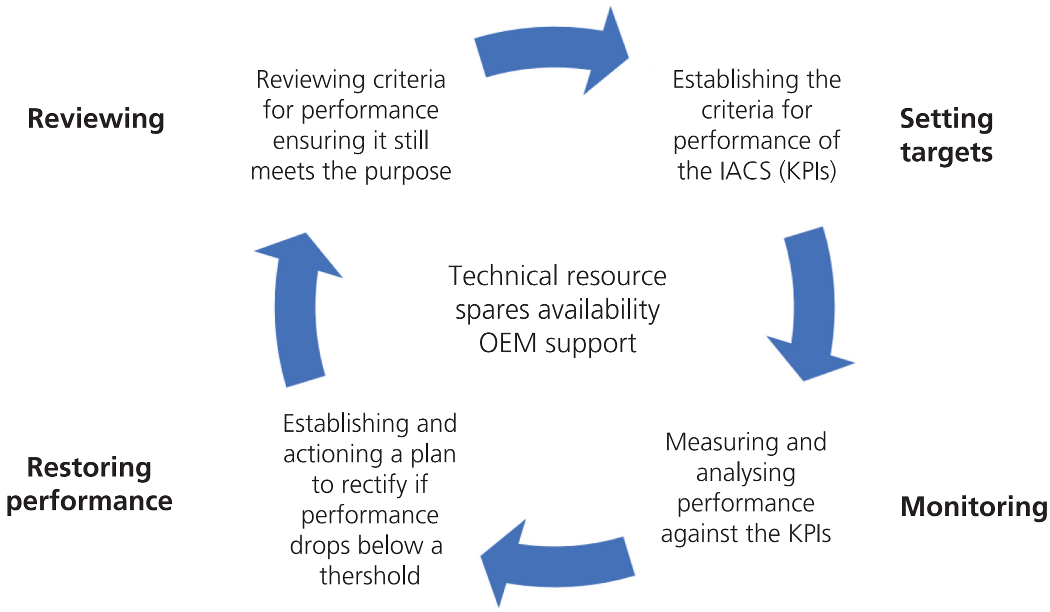

Figure 1: Typical IACS life cycle

1.4.1 Setting targets

There are several factors that can be used as means to determine overall IACS performance, and they should reflect the importance and duty of the IACS. Examples include:

- stock levels of parts;
- number of system alarms/faults over a period of time;
- categorisation of the nature/impact of a fault;
- time taken to repair following a fault;
- effectiveness and response of an OEM helpdesk;
- current (in-house) knowledge of the system;
- the ability to modify the system including introduction of new schemes and designs and/or extending/expanding the system;
- annual cost of maintaining;
- degree of vulnerability to cyber/malicious attack, and
- impact of any cyber attack (continuity of operation, local equipment damage, widespread plant damage, environmental contamination).

1.4.2 Monitoring

Once the factors have been identified, their performance thresholds should be set and can take the form of quantifiable or qualitative values. Formal routine monitoring of these factors should occur in order to plot trends in the performance of the IACS. Extended time in repairing a fault can result from shortage of stock but equally arise from lack of skill and knowledge, and so the results monitoring can also give insight into other areas of potential concern within the organisation.

1.4.3 Restoring performance

Regular maintenance, either by OEM service teams (such as software/firmware updates, system diagnostics, etc.), or from in-house staff would be in place as a matter of course. This part of the cycle is more about strategic planning in the event of anticipating or detecting poor performance. Examples could include what steps are to be taken in the event of a spares shortage, or how the system will be maintained over long holiday periods or extended periods of societal disruption.

1.4.4 Reviewing

This review stage should consider the full life cycle of the IACS. It should look at whether the IACS can continue to provide its original design intent, and whether it remains fit-for-purpose. There is no better example than the gradual creep of plant expansion to render an IACS unfit-for-purpose, particularly if its life cycle is not monitored. The review should also include the associated costs of continued upkeep (that should include a broad estimate of the cost of plant downtime due to failure) versus the cost of upgrade. In addition to this, and as cyber attack becomes more prevalent, the capability of the system in fending off such an attack may become obsolete and result in the provision of bolt-on features that can minimise the possibility. However, this may be only possible in more modern systems/architecture, in which case an upgrade may be the only viable solution.

The timing of whether an IACS requires an obsolescence programme to be invoked (upgrade or managing) is typically determined by a collection/culmination of issues rather than one single point. Each business/operator should have its own criteria, likely to be determined by the asset team. This team would set a range of factors that individually mean little, but collectively indicate a potential obsolescence issue. As an example, consider that (as of the time of publication) Microsoft Windows 10 Enterprise edition long-term servicing channel (LTSC) 2019 will no longer be supported after January 2029. That date would be recorded by the team, and it is very unlikely that they would do anything in the short/medium-term to address this. Another factor may be that the IACS OEM issues its forward notice for future non-supported parts/spares or, similarly, end-of-life notices that inform users when development, manufacturing and support is to be stopped. Individually, these are not immediate signs for action to be taken in the short/medium term. The combination of these factors would be enough to make the team start to consider obsolescence as a medium-term issue. When considering 'what are the lead times for decisions?', there is not one answer that fits all.

The main point to note is that it is more than likely to be a combination of factors that indicate the stage in the IACS life cycle where decisions relating to its future, i.e. whether to live with and manage obsolescence or to upgrade, are likely to be made.

1.5 ASSET REGISTER

An organisation's asset register plays a key part in managing obsolescence. Along with providing an overview of critical and non-critical plant and equipment, it allows the user to see what the key components are in any system and, where possible, include the obsolescence status of equipment. The IACS should be included on the asset register for successful management of this important system.

The asset register should include the organisation's risk graph that plots consequence and likelihood of failure of critical items (such as the IACS). In this way, the importance and related risk of the IACS can be compared with other critical assets to further highlight when the need to upgrade or manage obsolescence arises.

1.6 OBJECTIVE

This publication has been written in order to provide information and guidance on the factors that should be considered in the successful management of obsolescence of an IACS, by providing a practical approach and suggested courses of action. Each and every IACS is different as a result of its unique use, and varies depending on the industry. This publication takes a generic approach to the IACS, as the two courses of action can, to some extent, apply to all types of application.

The two courses of action discussed in this publication are:

- undertaking an upgrade to a new IACS, or
- living with and managing obsolescence if an upgrade is decided against.

The publication is aimed at those responsible for the operation, maintenance and update of IACS, including C&I engineers, IT engineers, project managers and project engineers responsible for upgrades, maintenance and IT technicians and risk management teams.

Note: when this publication refers to managing obsolescence (or obsolescence management), this means the active management of an IACS already deemed obsolete (or planning to allow the continued use of a soon to be obsolete system); in particular, actively preventing or managing the issues that would result from failure of the obsolete system (disruption to production, extended downtime, need for repairs, etc.), especially those exacerbated by the fact of its obsolescence (e.g. inability to get replacement parts). Management of the IACS prior to the point where an obsolescence management programme begins can be considered part of the normal IACS life cycle. As such, obsolescence management can be thought of as a form of life extension (albeit not specifically in response to age and wear and tear but rather other factors like availability and OEM support). It begins at a trigger point determined by the organisation, where the organisation considers whether to upgrade its IACS or whether to live with a (soon to be) obsolete system.