NTEPS 2019
Automation In Potentially Explosive Environments

June 2019
Mark Temple  
Manager, Business Development M&A  
[mark.temple@ul.com](mailto:mark.temple@ul.com)  
+1 346 412 7010  
Houston, Texas. USA  

[LinkedIn](https://www.linkedin.com/in/markrtemple)
The Digital Transformation of Oil & Gas & HazLoc Risk

• Industry 4.0 definition
• Digital Overview and Opportunities
• Regulatory overview - Hazardous Location 101 / refresher
• Challenges
So what is Industry 4.0?

<table>
<thead>
<tr>
<th>1. Industrial revolution</th>
<th>2. Industrial revolution</th>
<th>3. Industrial revolution</th>
<th>4. Industrial revolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follows introduction of water- and steam-powered mechanical manufacturing facilities</td>
<td>Follows introduction of electrically-powered mass production based on the division of labour</td>
<td>Uses electronics and IT to achieve further automation of manufacturing</td>
<td>Industrial revolution based on Cyber-Physical Systems</td>
</tr>
</tbody>
</table>

*End of 18th century*  
*Start of 1970s*

*Source: DFG 2011*
IOT
Internet of Things

IIOT
Industrial Internet of Things

Digital Twin
Digital replica of a physical asset

UX/UI
User Experience
User Interface

Big Data

Machine Learning
AutoML

XaaS (SaaS)
A subscribed service rather than bought (As A Service)
Software, Infrastructure,

Edge
Devices at the Plant Level

Fog
Taking the Cloud to the Edge

Cloud
Someone else's computer

Protocols
RFID, WiFi, BT, 5G, ZigBee
NFC, LoRAWAN, Sigfox

Predictive Analytics
Statistical analysis of new and Historical Data to forecast activity, behaviors and trends

STEPs Digital Bingo

Machine learning is an application of AI systems to automatically learn & improve from experience w/o being explicitly programmed
Why do we need to Transform?

**SAFETY**

Repeatable, Reliable and Accurate work

Create Augmented Operatives – Empowered to take on more work – **SAFELY**

More Time on Tools – Less fatigue due to Staff optimization

Risk Management & Insurance

Utilization of key SME’s leveraging a staff base with a new culture for work
In the US – there will be a downward shift of 11% in the 90Bn Skilled Staff between 2016 and 2030. This equal 17.2Bn less hours of skill horsepower available - that’s 9MM people

The Technological, Engineering and People Skills sectors will rise by 20MM jobs

If the estimated 9MM from skilled jump to this sector.....

...It leaves 11MM extra Technology jobs ...to fill in 11 years

This is all fixable – but its not recruitment..
A new type of ‘Expert’

In the past - expertise was based on *unconscious competency*...

‘She could do that job with her eyes closed’

With the ‘great crew change’ .. these competencies cannot be built because the people/coaches have retired

With mixed reality and some core skills... *conscious competency* wins... tasks will be executed with perfect repeatability... as close to being a *human robot* as you would want..

This is not a bad thing because with the that one person becomes empowered

Think about Automated Procedures and Workflows – Tracked, Auditable in real time remotely – only available to those with proven competencies. One SME for 1000’s of staff

Also – think of the benefits of training national staff internationally – visually – or simply translated in the local dialect
Increasing Risk…

So - We have a lot of new people, people from different technical backgrounds, and a lot of new equipment.

Risks in our industry may be new or different to the incoming resources.

There is a Tsunami of technology coming – a lot of the equipment will not be appropriately tested and certified for the appropriate location.

‘They don’t know what they don’t know’

The current legacy suppliers to industry are using this gap to relax diligence toward Testing and Certification.

Plausible deniability – ‘The end user didn’t specify it – so it doesn’t need to happen’
Example – HazLoc Risk Based Inspection

1. 100% Digital RRA
   Detailed & Prescriptive Validation
   EPCM Stage
   F.A.T. Stage

2. 100% RRA In Situ
   Simplified & Prescriptive Inspection
   Commissioning Stages
   S.A.T. Stage

3. RRA Periodic
   Simplified & Prescriptive Inspection
   Reliability & Maintenance Stage

4. +/- 3/4/10 Years on the Periodic Inspection
   Safely and Confidently

RRA – Repeatable, Reliable and Accurate

Product Data + Project Data

Product Intelligence

AI
ML
The ‘A’ in AML

1 2 3 4

Ul
Ul
Ul
Example – Augmented Fault Finding

THEN WE CAN LOOK AT INFORMATION FOR EACH COMPONENT
Example – Augmented Operations and Safety
HazLoc Basics

‘Ignition Source Management’

Empowering Trust™
Ignition source management is still a major source of property and casualty loss – and a focus of the Offshore communities

A Pemex-operated platform caught fire in the Gulf of Mexico on February 7, 2016 killing 4 and injuring 16
Hazardous locations

Potentially Hazardous Locations are dangerous places to work

- Flixborough, UK – 1974 – 28 lives lost
- Piper Alpha, North Sea – 1987 – 167 lives lost
- Norco, LA – 1988 – 7 lives lost
- Phillips, Pasadena TX – 1989 - 23 lives lost
- Sterlington, LA – 1991 – 8 lives lost
- Haysville, KS – 1998 – 7 lives lost
- Philips K-Resin, TX - 2000 – 1 live lost
- ICL Plastics, UK– 2004 – 9 lives lost
- Texas City Refinery, TX – 2005- 15 lives lost
- Georgia Sugar, GA – 2008 – 13 lives lost
- Deepwater Horizon, TX – 2010 – 11 lives lost
- West Texas, TX – 2013 – 15 lives lost
- KMCO, TX - 2019 – 1 live lost

305 people, each one someone’s Co-Worker, Colleague, Friend or Family Member
Getting worse?.....

WATCH LIVE: A large fire at Intercontinental Terminals Company in La Porte continued to burn overnight, spreading to an additional six tanks, a company update says. That brings the total to 8 tanks burning. https://bit.ly/2OeRNqE (Raw feed, no sound)

SANTA FE, Texas - Several gas company contract workers in Santa Fe were injured when a gas line exploded and sent a column of fire into the air.
Hazardous Electrical Equipment: At the time of the explosions, the electrical equipment installed in the “hazardous” areas of the MODU (where flammable gases may be present) may not have been capable of preventing the ignition of flammable gas. Although *DEEPWATER HORIZON* was built to comply with IMO MODU Code standards under which such electrical equipment is required to have safeguards against possible ignition, an April 2010 audit found that *DEEPWATER HORIZON* lacked systems to properly track its hazardous electrical equipment, that some such equipment on board was in “bad condition” and “severely corroded,” and that a subcontractor’s equipment that was in “poor condition” had been left in hazardous areas. Because of these deficiencies, there is no assurance that the electrical equipment was safe could not have caused the explosions.
As discussed in Chapter 1, this same audit found that had failed to properly track and maintain its hazardous electrical equipment on the Drill Floor, that the equipment was in “bad condition,” and that contractors had been allowed to leave equipment in poor condition on the Drill Floor. As a result, there is no assurance that such equipment did not ignite flammable gas to cause the explosions on April 20.
Hazardous Area Electrical Sources: Flammable gas may have been ignited by unguarded electrical equipment in hazardous areas on or near the Drill Floor. (see additional discussion below)

Additional possible ignition sources include:

Temporary Electrical Circuits: Another potential ignition source could have been temporary electrical circuits installed in hazardous areas on the Drill Floor to support current operations.
DWH April 2010

DEEPWATER HORIZON

B. _____________ failed properly to track and maintain Drill Floor electrical equipment that could have served as an ignition source.

However, the April 2010 _____________ audit found that DEEPWATER HORIZON lacked systems properly to track its hazardous electrical equipment and that the hazardous area electrical equipment on board was in “bad condition.” The audit determined that contrary to the IMO International Safety Management (ISM) Code, none of the classified electrical equipment on the Drill Floor had been tagged with an identification number, and the MODU did not have on board a hazardous area equipment registry or hazardous area drawing that would have identified both the classified electrical equipment and the boundaries of the hazardous areas. Since the crew did not have any means to clearly identify the classified electrical equipment or the extent of the hazardous areas, there can be no assurance that no unclassified fixtures were introduced into the hazardous areas during maintenance or modifications.
Industry has 3 considerations relating to compliance:

- PEOPLE
- PRODUCT
- PLACES
Area Classification Drawing
THE GLOBAL PRODUCT CERTIFICATION MARKETPLACE IS VOLATILE
THE GLOBAL PRODUCT CERTIFICATION MARKETPLACE IS VOLATILE
EUROPEAN UNION

ATEX and CE Marking will not go away in our careers.

....If you are shipping to Europe – it needs a CE mark
.....if it is going into a hazardous location in Europe – it needs an ATEX mark

• Also, other countries like ATEX, so don’t be surprised if you get a request for ATEX outside of Europe.
• Any third party certification has be done by a Notified Body.....
ATEX – NON ELECTRICAL (LEGAL)

6.2 Maintenance schedule

6.2.1 Routine inspection (daily/weekly)

**CAUTION**

The following checks should be made and the appropriate action taken to remedy any deviations.

a) Check suction and discharge gauges.

b) Check for abnormal operating condition.

c) Check control valve leakage.

d) Check vibration, noise and temperature at the satisfactory operation.

e) Check dirt and dust around close clearance areas.

f) Check coupling alignment.

6.2.2 Periodic inspection (monthly)

a) Check foundation bolts for security of attachment, corrosion, check grouting for looseness, cracking or general distress.

b) Change lubricants.

c) Check calibration of instruments.

d) Check coupling for correct alignment.

6.2.3 Periodic inspection (six monthly)

a) **CAUTION**

Check foundation bolts for security of attachment, corrosion, check grouting for looseness, cracking or general distress.

6.2.4 Inspection (after 3 years)

a) Check internal condition of pump and all ancillary pipework for corrosion/erosion.

b) Check internal pump components for wear.

c) Change bearings

4 INSTALLATION

**Ex** Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See section 1.6.4, *Products used in potentially explosive atmospheres.*

5.7.3 Bearings

**Ex** If the pumps are working in a potentially explosive atmosphere temperature or vibration monitoring at the bearings is recommended.

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilised (see 5.2.4.1 for temperature limits).

4.9 Protection systems

The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in doubt consult Flowserve.

If there is any possibility of the system allowing the pump to run against a closed valve or below minimum continuous safe flow a protection device should be installed to ensure the temperature of the liquid does not rise to an unsafe level.
ATEX MECHANICAL CERTIFICATION
CE MARKING – LEGAL REQUIREMENT

If a manufacturer falsely CE marks a product or fails to CE mark a product for which it is required, the maximum penalty is three months in jail and a £5,000 fine for the director of the offending company.
THERE ARE SYNERGIES IN THE REQUIREMENTS

<table>
<thead>
<tr>
<th>North America Art. 500 (c UL us)</th>
<th>ATEX</th>
<th>IECEx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can other Schemes be used for Certification</td>
<td>Yes; A valid IECEx report can be used along with US/CAN deviations to obtain a Listing</td>
<td>Yes; A valid IECEx report can be used along with EN deviations to obtain a Type Certificate</td>
</tr>
</tbody>
</table>

The North American mainland is pretty straightforward

- Labels and Stickers or…
- Approval from an AHJ – Authority Having Jurisdiction
- Usually installed by electrical craft not focused on packages or systems
Interpreting the Markings – Divisions

If certified:

- NRTL / certification agency mark
- Typically a traceability marking (e.g. file or certificate number)
- Typically a product identity (e.g. “Tank Monitoring Equipment for Use in Hazardous Locations”)

Warning markings

Reference to manual, control drawing, etc. as applicable

Ambient temperature range

- if other than -25°C to +40°C (per the NEC)
Types of International Certificates

Certificate of Conformity

• Complete equipment
• May cover a series
• May contain Special Conditions of Safe Use

Certificate of Component

• Incomplete equipment
• May cover a series
• Will include a Schedule of Limitations or Conditions of Component
HAZARDOUS AREA CLASSIFICATION

Customer - “Please provide a product for IECEx and ATEX Zone 1 plus Class 1 Div 1 “

You can’t!!

There are four elements to product specifications..

1 - Likelihood of the gas been present – that’s

2 – The Gas and/or Dust Group of the hazardous area of installation (IIA, IIB, IIC, IIIA, IIB, IIIC)

3 - The Ignition Temperature of the hazardous gas – The temperature or T class (T1 – T6)

4 – The ambient temperature of the location to be used (Standard cert is -20°C to +40°C)
<table>
<thead>
<tr>
<th>Zone</th>
<th>IEC Class</th>
<th>ATEX Category</th>
<th>IEC EPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>II</td>
<td>1G</td>
<td>Ga</td>
</tr>
<tr>
<td>1</td>
<td>II</td>
<td>2G</td>
<td>Gb</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>3G</td>
<td>Gc</td>
</tr>
<tr>
<td>20</td>
<td>III</td>
<td>1D</td>
<td>Da</td>
</tr>
<tr>
<td>21</td>
<td>III</td>
<td>2D</td>
<td>Db</td>
</tr>
<tr>
<td>22</td>
<td>III</td>
<td>3D</td>
<td>Dc</td>
</tr>
<tr>
<td>I</td>
<td>M1, M2</td>
<td>Ma, Mb</td>
<td></td>
</tr>
</tbody>
</table>
THE UNICORNS PROBLEM

Testing and Certification for Class and Division can be different from Class and Zone…

Also - Div 1 is comparative with Zone 0 – You can buy a Div 1 squirrel cage motor but not a Zone 0 one.

Subtle differences trip cause some pitfalls in achieving the unicorn…

Selecting the right components at the front end design and ideation phase is key

… a subtle change in a PCB design may miss a compliance opportunity…

(ref: IEC 60079-11 Ex ‘i’ from IEC 60079-15 Ex ‘nL’

UL
HazLoc Technical compliance requirements differ internationally

...so if you were developing a ‘global’ product

... what compliance model would you choose?
US Offshore Regulatory Frameworks

- Two groups talk about collaboration on regulations but the output is still not fully aligned.
- The USCG has released regulatory information regarding IECEx
- BSEE are working on their strategy
But - the USCG opened up the minds of the regulators

The USCG recognizes that equipment certified under the ATEX scheme could have been through third party approvals

BUT, the supporting document to their new regulation says:

*The Coast Guard.. Will not accept ATEX certification because evidence of full testing to the applicable harmonized 60079 series of standards by a third-party laboratory is not guaranteed*
Now in force

DEPARTMENT OF HOMELAND SECURITY
Coast Guard
33 CFR Parts 140 and 143
46 CFR Parts 110 and 111
[Docket No. USCG–2012–0850]
RIN 1625–AC00

Electrical Equipment in Hazardous Locations

AGENCY: Coast Guard, DHS.
ACTION: Final rule.

DATES: This final rule is effective April 30, 2015.

SUMMARY: The Coast Guard is issuing regulations applicable to newly constructed mobile offshore drilling units (MODUs), floating outer continental shelf (OCS) facilities, and vessels other than offshore supply vessels (OSVs) that engage in OCS activities. The regulations expand the list of acceptable national and international explosion protection standards and add the internationally accepted independent third-party certification system, the International Electrotechnical Commission System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX), as an accepted method of testing and certifying electrical equipment intended for use in hazardous locations. The regulations also provide owners and operators of existing U.S. MODUs, floating OCS facilities, vessels other than OSVs, and U.S. tank vessels that carry flammable or combustible cargoes, the option of following this compliance regime as an alternative to the requirements contained in existing regulations.
**Anything missed?**

*Electrical Equipment Inspection and Maintenance Requirements*

Five comments recommended that the Coast Guard establish standards for the design, installation, inspection, and maintenance of electrical equipment in hazardous locations. Two comments suggested requiring an onboard electrical equipment register that contains information regarding electrical equipment and its inspection, maintenance, and operational history. The commenters also suggest this information could be reviewed by visiting Coast Guard marine inspectors or third-party inspection personnel and could become part of a company’s quality system. We agree that competency and accurate recordkeeping are critical to safety, but this recommendation is outside the scope of this rulemaking.

- US based compliance is heavily based on PRODUCT compliance
- There was an opportunity to leverage the competency requirements of the IECEx standards
So the critical factor comes back to the human’s.

People who ‘don’t know what they don’t know’ is on the rise

Hazardous Location compliance is at risk – it is a very specialized subject from electrical design to maintenance.

There are industry schemes to train to a ‘10’ level through to discrete design classes – Online in learning management systems through to practical week long classes.

Training should cover EVERY stakeholder – Sales, Design, QA/QC, Engineering Management, C-suite – otherwise buy in to the extra expense is difficult.

Digital Solutions are available!
ANNEX

INTERIM GUIDELINES ON SAFETY FOR
NATURAL GAS-FUELLED ENGINE INSTALLATIONS IN SHIPS

8.3.4 Any personnel that should carry out inspections and maintenance of electrical installations in explosion hazardous spaces should be qualified pursuant to IEC 60079-17, item 4.2.

***

18 Refer to IEC 60079-17:2007 Explosive atmospheres – Part 17: Electrical installations inspection and maintenance.

I:\MSC\86\26-Add-1.doc
Example – HazLoc Competency
Are the regulators ready?

- Lieutenants
- Lieutenant Commander
- Commanders
- Civilian Inspectors
- Technicians
Thank you!

www.ul.com/hazloc
mark.temple@ul.com
346 412 6062