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# Individual, team and organisational human factors

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## Why are we concentrating on maintenance*?

- Lots of studies performed in this area, findings include: -
    - 56% of forced outages occurred less than a week after a planned or maintenance shutdown
    - 20% of all system failures in fossil power plants occur due to human failures
    - 55% - 65% of all problems associated with maintenance are related to human performance
- Maintenance errors are dangerous and expensive

* Or repair, calibration, testing, modification etc.

Of course, human factors applies to everything we do, in and out of work. In work, we should consider all elements of the organisation, work group and task, operations, maintenance, planning, management etc. But as I only have 20 minutes, let's look at maintenance.

Repairs, maintenance, calibration, testing and modification all require people to interface with equipment. When we do this, we introduce the potential for human error at the individual, team and organisational level.

Not only can people damage equipment, but can introduce safety related problems that may not surface during the job or immediately afterward. These latent failures can place us at risk for days or years afterward.

Let's not forget that the largest fire and explosion in Europe since 1945 at Buncefield was partly caused by an error in testing that happened months before the incident.

# Resistance is Futile!

- The BAD News is that..
  - Human errors are inevitable
  - Everyone makes them

If we accept that some level of error is inevitable and that we are all vulnerable to errors then we can go a long way toward creating a culture that can mange, reduce and mitigate the consequence of error.

# But don't worry

- The GOOD news is that
  - No one actually intends them to happen (mostly)
  - They don't occur as a result of random events in peoples minds
  - Human errors are the consequence of local circumstances
    - The task
    - The tools and equipment
    - The workplace and environment
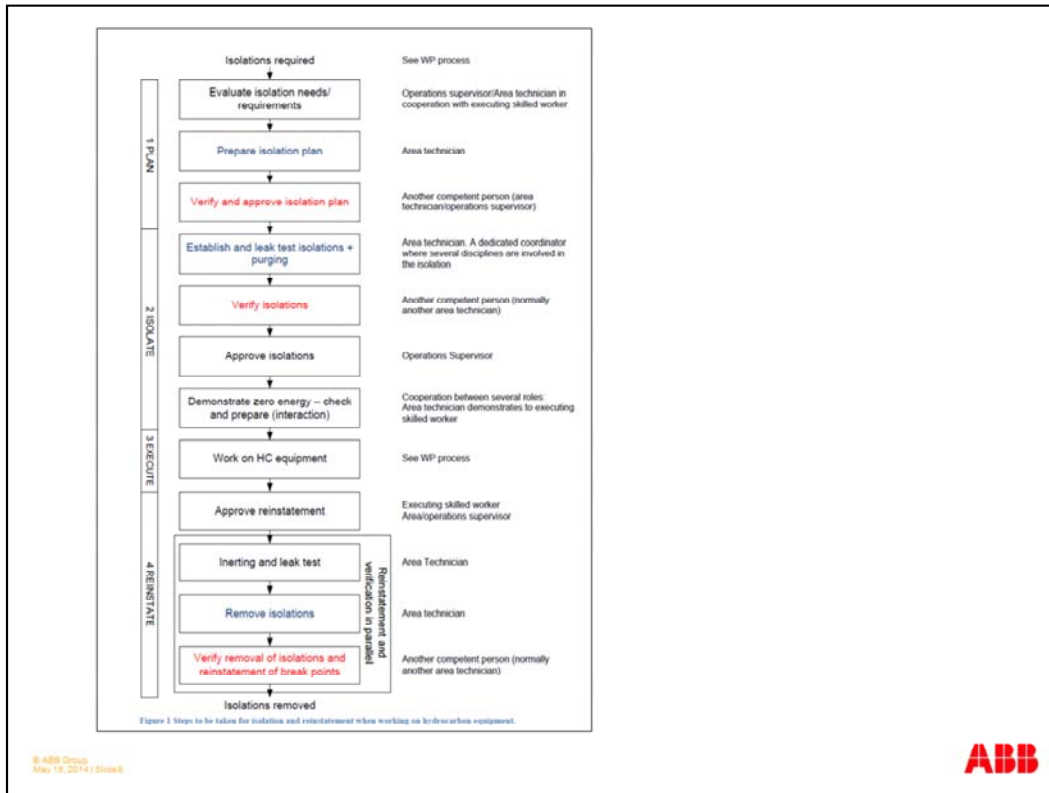
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# Traditionally…

- Punish, council and train people

- Write new procedure or work instruction to make sure it doesn't happen again

- Unfortunately, research by behavioural psychologists show that neither of these approaches is likely to be successful

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# Better Way of handling Human Error

- Errors are a combination of human behaviour and task conditions

- Treat human errors as normal, expected and foreseeable

- Manage the errors by changing the conditions under which the work is carried out

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We do this by looking at the fundamental capabilities and limitations of people and the local circumstances that make errors more likely, or less likely, or more likely to be recovered from.

Figure 1 Steps to be taken for isolation and reinstatement when working on hydrocarbon equipment.

If we consider error to be normal we can anticipate the errors that are most likely to occur at any step in a known task and even understand the risk of an unplanned task. So, for example, this is your best practice definition for isolation when working on hydrocarbon equipment.

By applying good human factors practice from experienced practitioners we can anticipate the vulnerabilities and design equipment, processes and people appropriately.
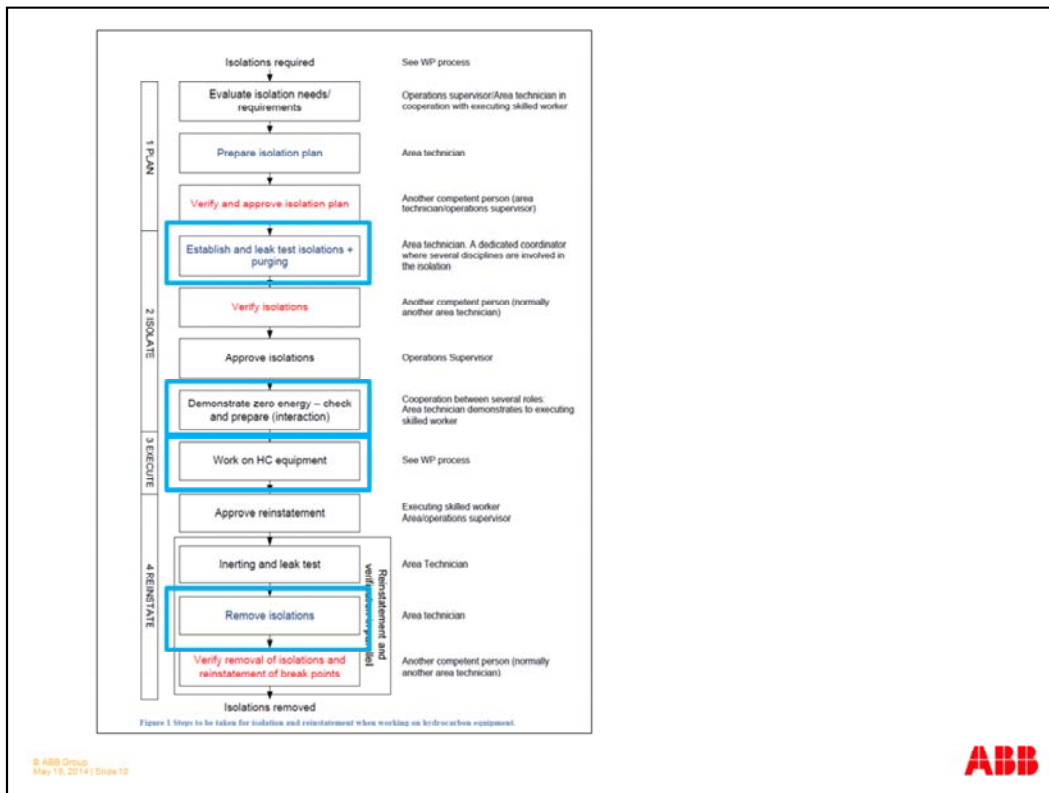
Each of these steps can be examined, but let's consider a few by way of example.

Figure 1 Steps to be taken for isolation and reinstatement when working on hydrocarbon equipment.
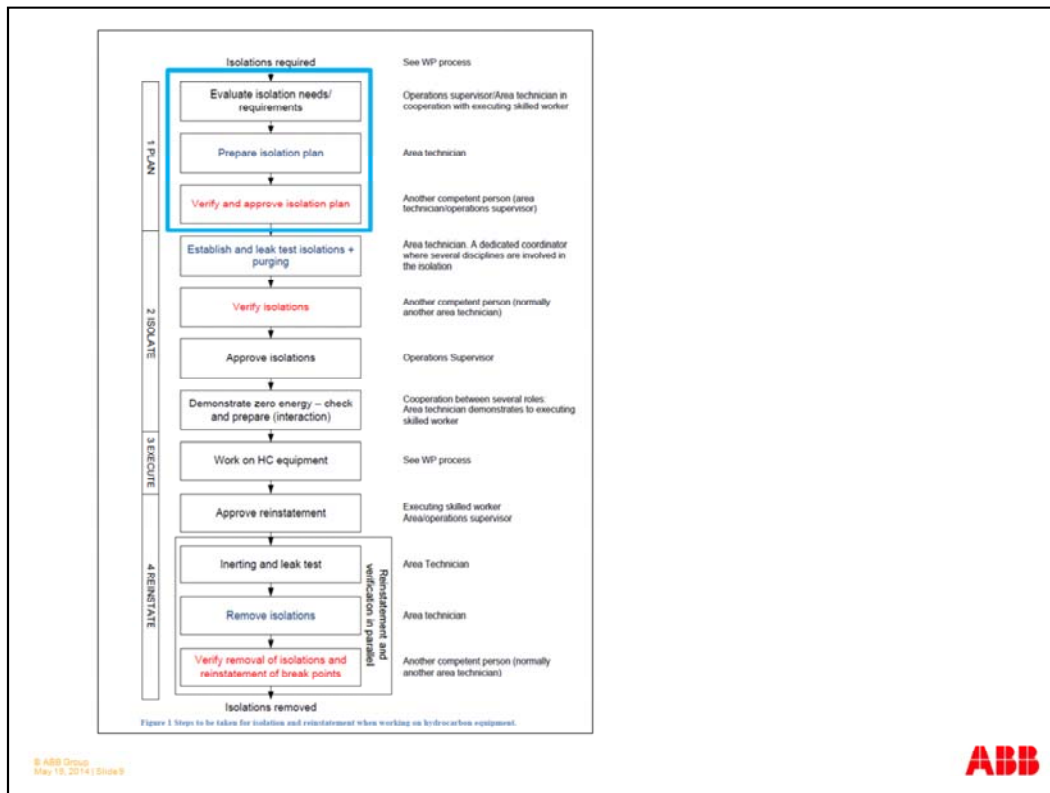
At the planning stage we begin to be vulnerable to human error. What we do in planning the job will affect the chance of error further down the process. For example, is there a difference between a scheduled and commonly performed isolation, and an isolation required for an emergency repair?

The stresses on the individual or team performing the task will be very different between the two circumstances, and more time may be required to safely carry out the latter without putting perceived time pressure onto the task. However the first should also be considered. Routine planned tasks by skilled individuals are particularly vulnerable to interruption, which introduces the potential for error. Routine tasks have other vulnerabilities, such as routine and institutionalised violations. This can be managed at the planning stage, but is also influenced by culture and other organisational factors.

Time is not the only variable that needs to be considered when planning. Issues of supervision, competence fatigue, and support may also be different between routine and non-routine tasks. People planning tasks and performing risk assessments need to be aware of this and plan the task appropriately.

Figure 1 Steps to be taken for isolation and reinstatement when working on hydrocarbon equipment.

When we move from the planning and mental model of the plant and process, we are vulnerable to 'doing the right thing to the wrong object', a common error type. It is important that not only layout and labelling is clear and consistent, but that those identifying and verifying the correct equipment are fully cognizant of the plant and equipment.

However, many of the factors that influence the probability of error are predictable and can be identified and corrected.

Here's a typical example of an error waiting to happen. The equipment is laid out in ACB order.

Errors of this type are often recovered by the people involved before it becomes a problem, but it is all too common that the 'near miss' of approaching the wrong equipment remains unreported. Organisational safety culture and 'human factors aware' personnel are required if these near misses are to result in real improvement.

The more we tolerate this type of design, the less safe we are.
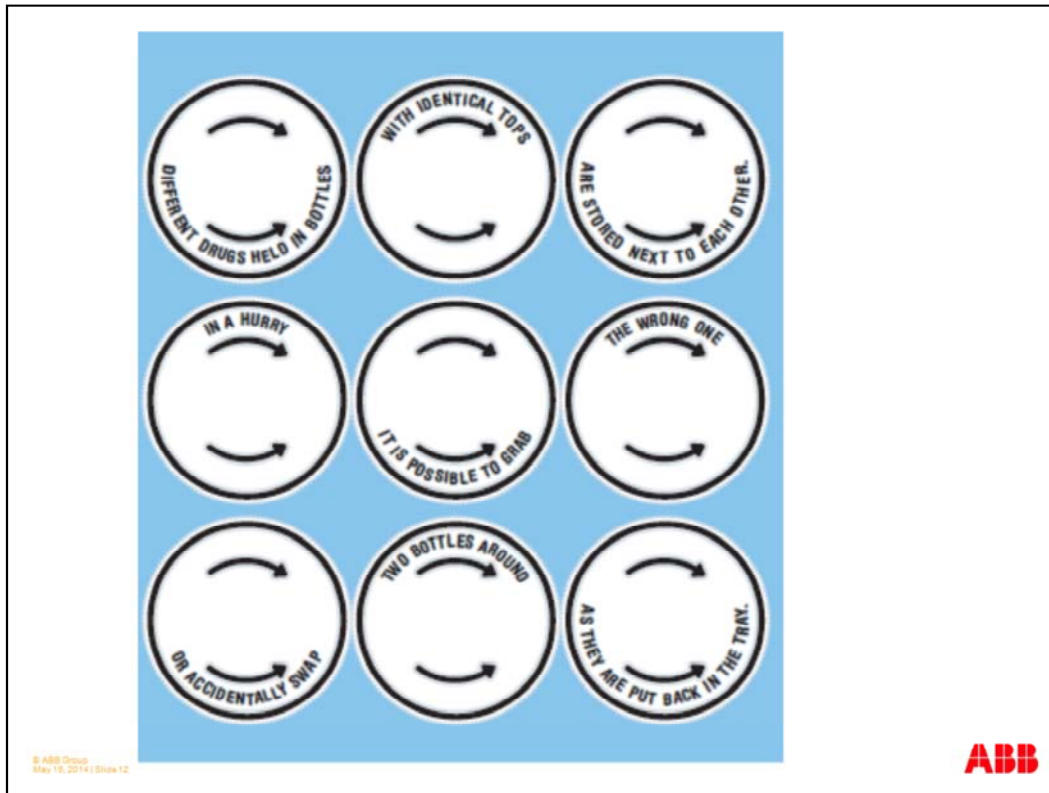
Here's an example from healthcare. It was common to store bottles of pills in a tray format where only the top was visible. As the tops were identical, the dispensing nurse had to rely on knowledge of position to select the correct bottle. If a bottle was 'misfiled' each subsequent pick was prone to selection error. A redesign of the tray allowed a better recovery path involving the label, and reduced the incidence of mis-dosing.

Here's an example from a safety critical panel that introduces needless complexity and a 'mapping' element to the operation of the controls.

The linear indicators at the top of the panel have to be mentally mapped to the four keyswitch controls.
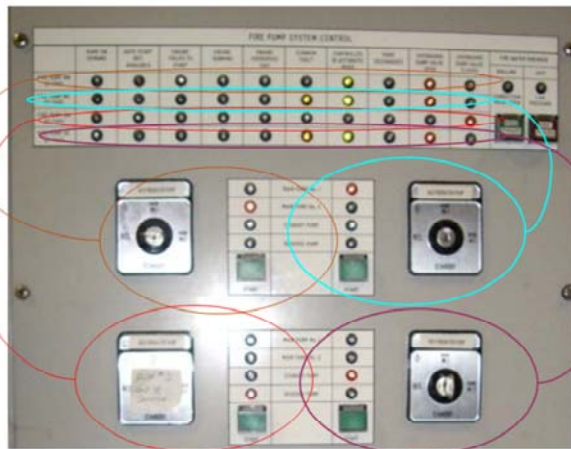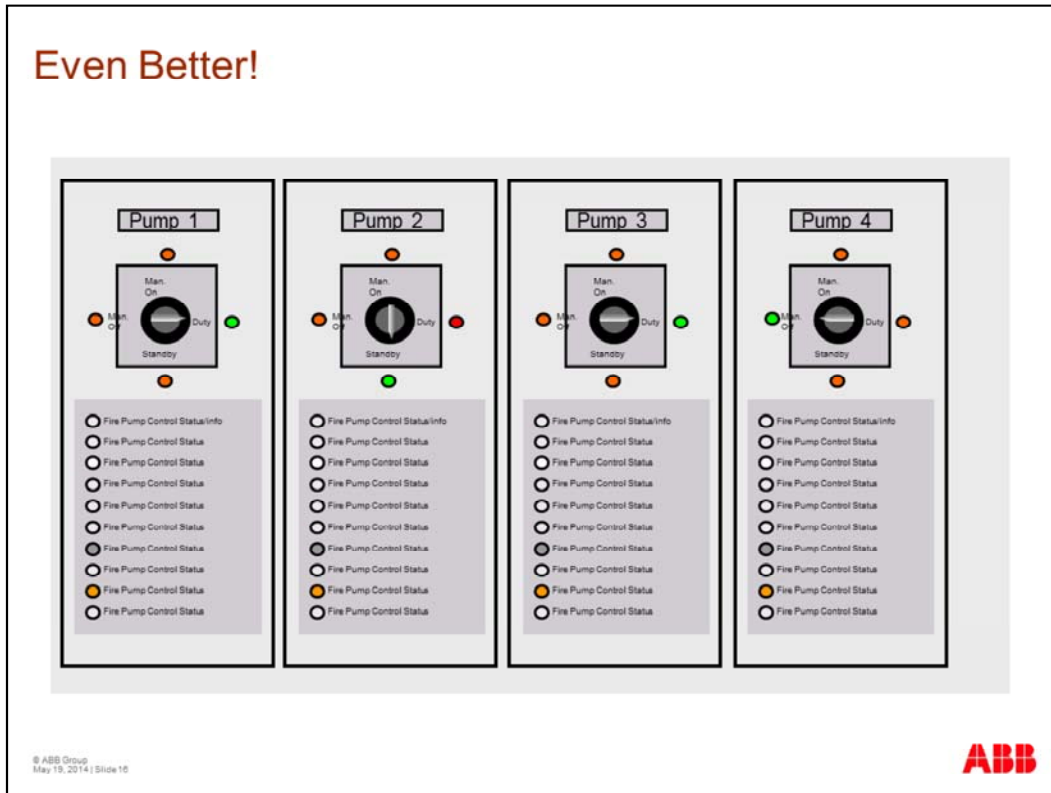
While the mapping might appear obvious, each person has their own 'view of the world' that is used when mapping a two dimensional array to a linear set of controls or vice versa.
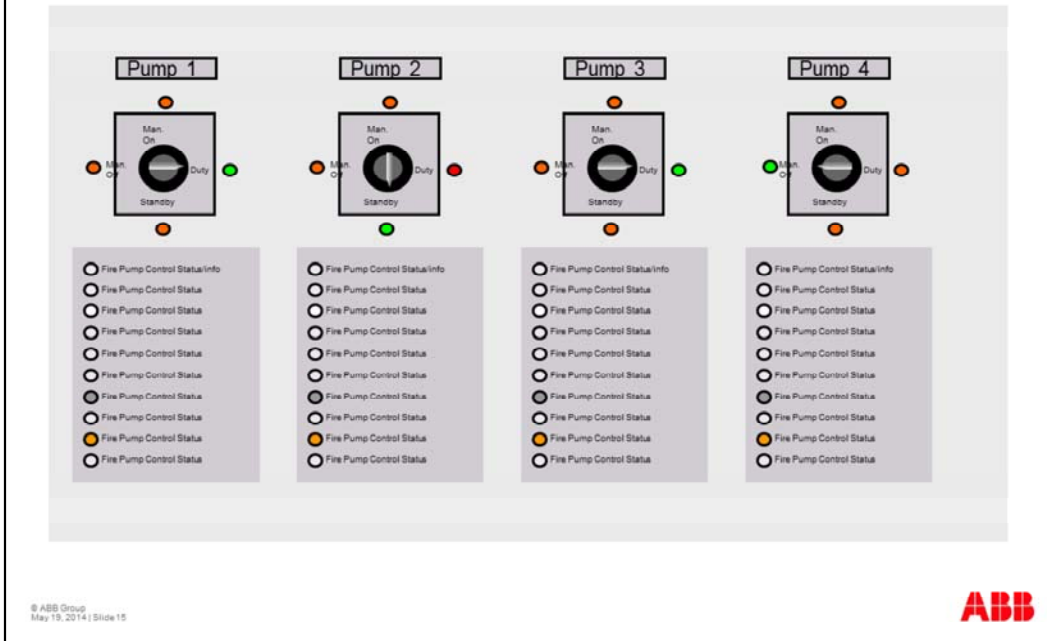
How much better to remove the mapping element from the cognitive task and remove a potential selection error.

Even better, simply add some lines to emphasise the functional grouping.

We can learn from other industries. Here's two designs of hob that face the same problem. One is prone to error, the other not. This design problem of mapping linear controls to other patterns is even called 'the cooker problem'.
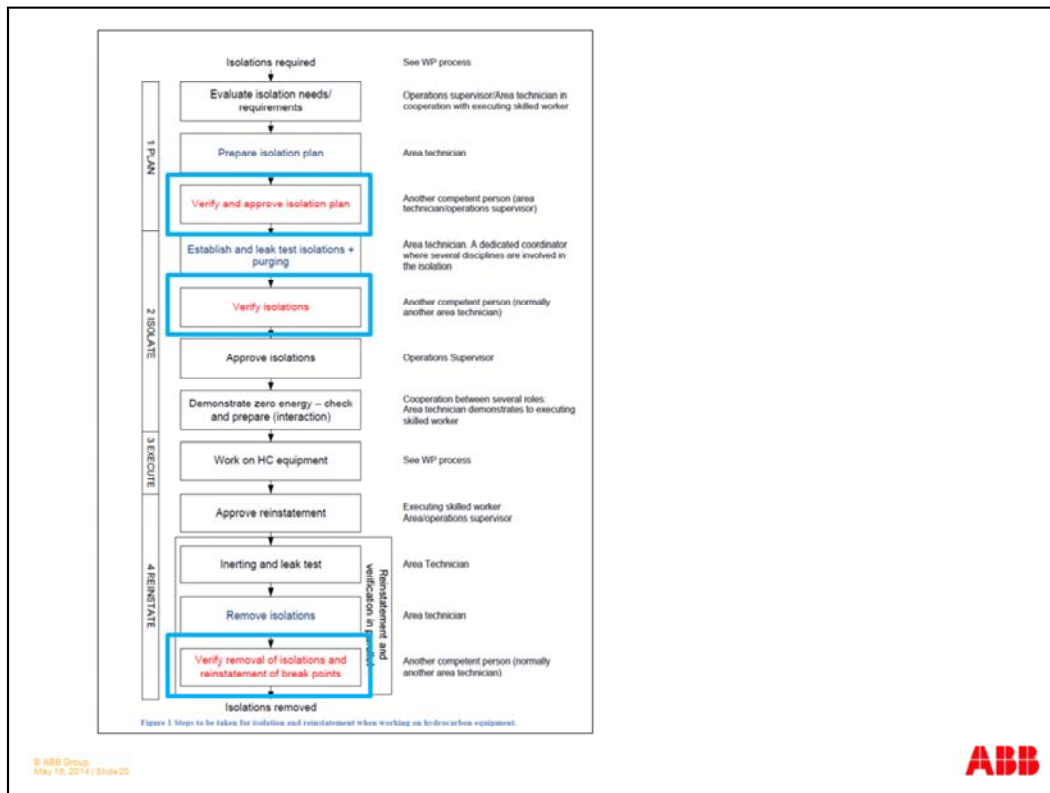
Even when we get things superficially correct, we can have problems. The 'right to left' labelling is fine for some cultures if it follows the written language convention. But be careful if the design is reused in a different culture or if you buy from overseas.

The lack of a gauge '915' is also a problem. An assumption that the panel reads 913, 914, 915, 916 would lead to an obvious error.

It's even worse for the technician working from behind! No labels at all.

Figure 1 Steps to be taken for isolation and reinstatement when working on hydrocarbon equipment.
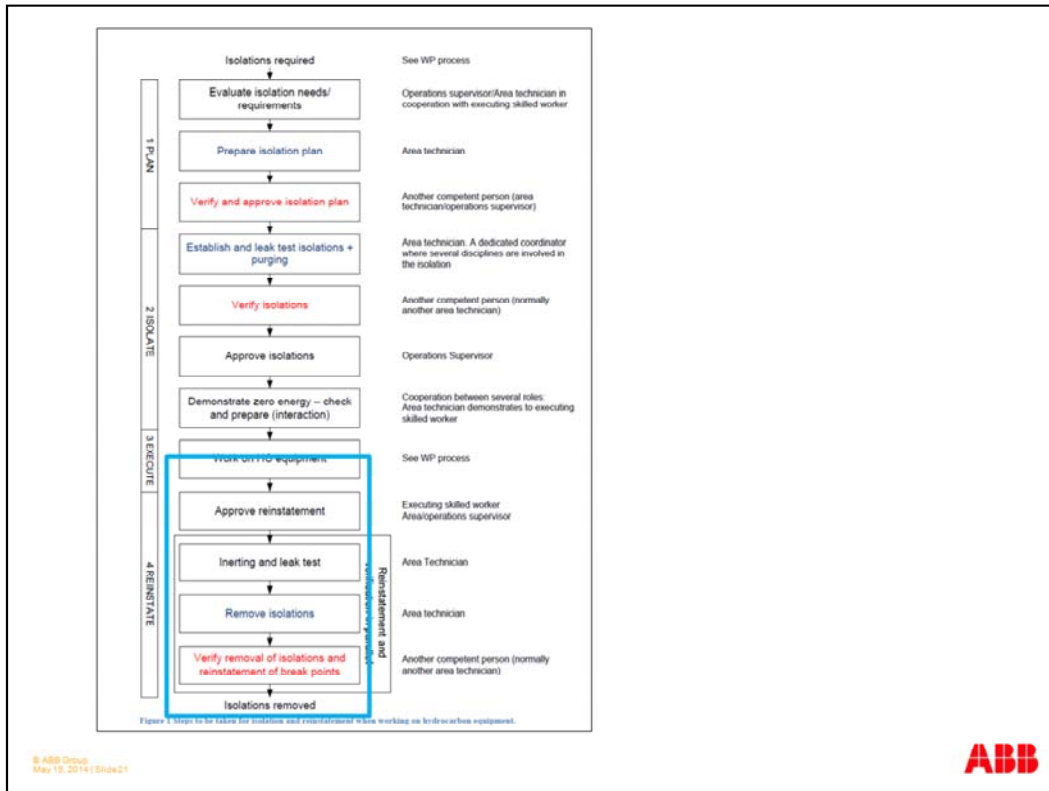
We have multiple verification steps in our safe working process. These verification steps are also subject to human error and defences can be put into place.

People do not behave like equipment. It can be tempting to say that if there is 10% chance of an error being made, then an independent check with a 10% error rate will bring the probability to 1% as the two tasks are in theory independent. However, few human tasks are truly independent and many are subject to systematic error. Verification and quality checking tasks need to be designed carefully if they are to be effective.

As well as systematic errors, signal detection theory allows us to consider checking and verification tasks for optimal performance. Quality control checks have their own science, with factors such as error rate and sensitivity and consequence affecting the performance of the task.

Even knowledge that there will be someone checking your work may affect the chance of error or violation. 'Diffusion of Responsibility' (psychologist speak for 'someone else's' problem') can have profound effects both within the high hazard industries and outside. In extreme cases this can cause a 'bystander affect' may result in no one actually performing the required action adequately. The bystander effect was coined following an incident in New York in 1964 when Kitty Genovese

was stabbed to death. Thirty seven people witnessed the event, but no one called the police as they assumed that someone else would do so. Knowledge that someone else will be checking you isolation will inevitably have an effect on the quality of isolation, positive or negative.

Figure 1 steps to be taken for isolation and reinstatement when working on hydrocarbon equipment.

We know that these elements of a task that are related to completion and closure are more vulnerable to 'completion errors' where the final parts of a job are omitted.

A good (but not safety related) example is photocopying. How many people have taken the copies away from the job, but left the original behind? This is because the job is to 'create copies' and the retrieval of the original is not considered as integral to the task.

In the oil and gas field, these errors may result in a dust or weather cap not being replaced after calibration, leading to a failure of the instrument in six months or a year. More seriously, as British Airways found out, the failure to secure the maintenance access to the engine, leading to a mid-air engine fire.

Note that this is an entirely predictable error in that it has happened multiple times to multiple aircraft in multiple companies.

Renault now require the ignition key to positively lock the fuel filler cap to prevent leaving the cap on the roof of the car, a classic 'failure to complete' error.

Image courtesy of Google images. 'Free to use even commercially'.
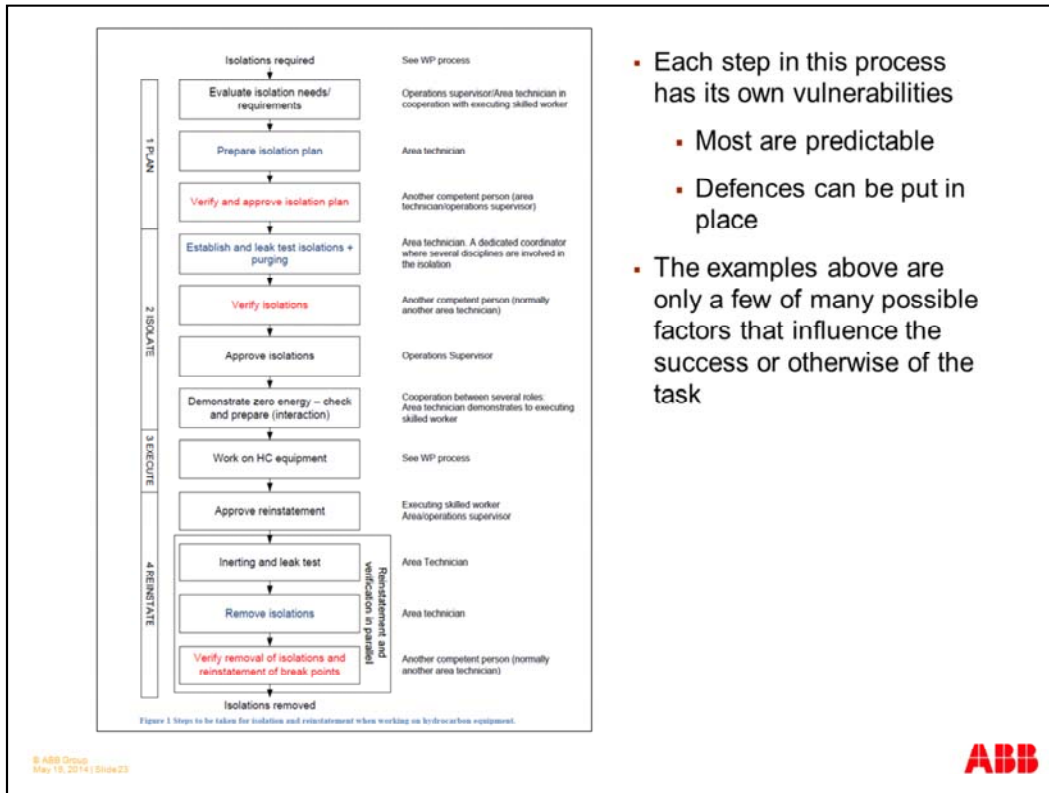
Each step or element of each task has its own characteristics and vulnerabilities to human error. The planning elements will be different to the execution elements or the checking and verification elements. But each can be considered from the human perspective and barriers to error put into place.

The areas I have described earlier are just examples, there are many more that can and should be considered.

There are some basic things that can be done to address human error in safety critical industries.

Basic training allows people to recognise the potential for human error and, in some cases, take action to avoid either the error or the consequences of error.

Recognising the potential for error is not enough. We should build a culture that wants to eliminate error not just for the individual, but for others who might be exposed to the error provoking circumstances. Eliminate the issue at source.

We can and should employ experts to help us in these tasks. Being human only gets us so far in understanding human behaviour and limitations. And we should not limit ourselves to 'human factors' experts or industrial psychologists. Sociologists and even anthropologists are generating valuable insights into the culture of many organisations, in the operational, maintenance, management and engineering functions.

And finally, we should look to other sectors and industries for learning and experience. We all share a single component, the mk.1 human being. This component is prone to similar 'failure' whether installed in a hospital, a flight deck,

or an offshore platform.

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