Offshore Composite structural repairs vs global safety approach

Christophe Paillusseau
COLD PAD
130 rue de Lourmel
Paris, 75015
France

Jean-Philippe Court
COLD PAD
130 rue de Lourmel
Paris, 75015
France

Genaro Zanon
Petrobras
Av. República do Chile, 65
Rio de Janeiro, 20031-912
Brazil

Philippe Noury
DNV GL
Veritasveien 1
Høvik, 1363
Norway

Key words: Asset integrity, composite structural repairs, life extension, global safety, FPSO

ABSTRACT

When planning site maintenance or life extension operations in offshore oil and gas platforms, most operators consider the following drivers in order of importance: safety, economics and very often POB (personnel on board). Operators may pick up in today's available toolbox several repair methodologies that can be split between standard hot work techniques (i.e. welding and cold work techniques (composite repairs, structural adhesive bonding). Due to the ATEX or Ex-Rating (explosion-hazard zones) of several areas on a Floating Production Storage and Offloading (FPSO)/Floating Storage and Offloading (FSO), the technique selection is not straightforward and highly depends on each operator actual decision drivers. However, reality shows that many aged outfitting equipment such as pipe supports, handrails, ladders or cable trays are either left not repaired/maintained or repaired/maintained using hot works. This creates in both cases safety risks for both personnel and asset.

Typical repairs of those items usually include standard hot work techniques like welding or grinding, which need a special hot work permit and more often an authorization during a planned shutdown. Due to limited POB capacity during those sporadic planned shutdown periods, operators focus on the maintenance of the items that are key to production. This means that "the least critical items with regards to direct production" such as tertiary steel structures remain on the "maintenance backlog" for several months and even years, creating real safety concerns. In a nutshell, decision drivers may become economics or POB before safety.

This work focuses on maintenance of a tertiary steel structure item carrying a safety function: corroded handrails. By evidencing compliance of cold work repairs with safety standards for most of the less critical outfitting issues, the industry has an opportunity to come back to a safer situation.

The work assesses the need for a holistic safety approach for FPSO repairs and life extension, including site repair maintenance, safety of personnel and asset, and performance during service life. Comparative Qualitative Risk Assessments are performed for three different scenarios: doing nothing, repairing with conventional hot work techniques, maintaining with cold work solutions. Fire safety

analysis is carried out and results are examined. Benefits and drawbacks of a fire sensitive component using polymer are evaluated against implementing other classical hot works.

Development (theoretical framework, methodology and results)

A global safety approach is then performed by comparing standard maintenance operations using welding and a cold repair solution for handrail support maintenance. Handrail support has been selected amongst other tertiary steel items (pipe supports, ladder, cable tray, tubing supports, etc) because of its safety function. Demonstrating compliance of handrail with safety requirements would cover most of the other tertiary steel items listed above and less critical in terms of safety.

It is not uncommon to see handrail supports heavily corroded in an offshore asset, notwithstanding that it is unsafe to use an unstable handrail and that it is used daily.

Risks are assessed through a typical risk analysis principle and ranked according to a risk matrix, as per Class Society standards [1].The risks identified for each scenario are compared with the input of both an operator and a vendor perspective. Case 2 (hot work repair) and Case 3 (cold work repair) matrixes are presented in Figures 1 & 2. A cold work repair of a handrail decreases the risk level from Very High (VH) for the Case 1 scenario (doing nothing) and High (H) or Very High for the Case 2 scenario to Low (L) or Medium (M) because the probability of occurrence of the danger is reduced. It means that cold work techniques for such a repair improve drastically the overall safety.

Conclusions

Cold work solutions for tertiary steel maintenance and repair can lead to safer assets compare to traditional hot work solutions.

It can be concluded that:
- The likelihood of holding a handrail in case of fire is seldom, as the presence of fire in the pertaining access way is likely to prevent the personnel from using it.
- In the unlike event the handrail is used despite the fire, the bonded support integrity could not be ensured, due to the severe temperature. However, the probability (P) associated to this event is fairly small (say, below 10^{-4}).

Thus, the risk (= probability x consequence) of a cold repair becomes much lower than keeping a faulty handrail support since it could be used daily (say, $P=10^{-2}$), considering that the consequence of support failure would be similar in both cases.
Moreover, in case the repair of this handrail support is performed using welding, the risk would then become high, mainly because of heavy consequences of a fire/blast generated due to hot work.

Cold work techniques are then an opportunity for the offshore oil and gas industry to maintain high safety standards at a reasonable cost. This innovative solution proves to be acceptable and efficient for most offshore repair needs (more than 50%).

Nevertheless, the paper showed that fire risk perception can be misleading and may prevent introduction of bonded solution. To avoid this cognitive bias, it is recommended to use well proven methodologies such as fire risk assessment, fire engineering and qualitative and quantitative analyses to establish reliably and objectively safety levels.

REFERENCES

1. DNVGL-RP-A203 Edition June 2017 (latest revision), “Technology qualification” (Høvik, Norway: DNV GL AS Region Norway).

2. Report N° 2019-0209 Rev 02 (latest revision), “Fire Risk Identification Workshop for C-Claw System” (Høvik, Norway: DNV GL AS Region Norway).

Case 2: Repair loose handrail fastening with hot work on producing FPSO above COT

Welding in explosive/flammable environment

Entering in confined space + scaffold erection for paint touch up at height on the opposite side (not assessed here)

Consequence Categories				Increasing probability				
				1	2	3	4	5
Severity	Safety	Environment	Cost (million Euro)	Failure is not expected $< 10^{-5}$	Never heard of in the industry $10^{-5} - 10^{-4}$	An accident has occurred in the industry $10^{-4} - 10^{-3}$	Has been experienced by most operators $10^{-3} - 10^{-2}$	Occurs several times per year $10^{-2} - 10^{-1}$
E	Multiple fatalities	Massive effect Large damage area, > 100 BBL	> 10	M	H	VH	VH	VH
D	Single fatality or permanent disability	Major effect Significant spill response, < 100 BBL	1 - 10	L	M	H	VH	VH
C	Major injury, long term absence	Localized effect Spill response < 50 BBL	0.1 - 1	VL	L	M	H	VH
B	Slightly injury, a few lost work days	Minor effect Non-compliance, < 5 BBL	0.01- 0.1	VL	VL	L	M	H
A	No or superficial injuries	Slightly effect on the environment, < 1BBL	< 0.01	VL	VL	VL	L	M

Increasing consequences →

Figure 1: Risk Matrix in case of hot work repair [2].

Case 3: Repair loose handrail fastening with NO hot work

Personnel exposed to instable handrails only in the event of fire

Consequence Categories				Increasing probability				
				1	2	3	4	5
Severity	Safety	Environment	Cost (million Euro)	Failure is not expected $< 10^{-5}$	Never heard of in the industry $10^{-5} - 10^{-4}$	An accident has occurred in the industry $10^{-4} - 10^{-3}$	Has been experienced by most operators $10^{-3} - 10^{-2}$	Occurs several times per year $10^{-2} - 10^{-1}$
E	Multiple fatalities	Massive effect Large damage area, > 100 BBL	> 10	M	H	VH	VH	VH
D	Single fatality or permanent disability	Major effect Significant spill response, < 100 BBL	1 - 10	L	M	H	VH	VH
C	Major injury, long term absence	Localized effect Spill response < 50 BBL	0.1 - 1	VL	L	M	H	VH
B	Slightly injury, a few lost work days	Minor effect Non-compliance, < 5 BBL	0.01- 0.1	VL	VL	L	M	H
A	No or superficial injuries	Slightly effect on the environment, < 1BBL	< 0.01	VL	VL	VL	L	M

Increasing consequences →

Figure 2: Risk Matrix in case of cold work repair [2]