SELF ELEVATING PLATFORM (INCL. LIFTBOAT) INCIDENTS

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ABSTRACT
Similar to that documented in the history of Jack-Up MODU operations, a trend can be observed in Self Elevating Platform and Liftboat incidents since 1965. The modern Liftboat is different from its original design and purpose. The supply of vessels with self-elevating and crane-lift capability followed the growing demand for cheaper vessels able to move swiftly and perform multiple tasks. The large demand for O&G supporting activities in the 80's, with too many incidents, led to development of standards for liftboats in 1989. More hazards evolved in the 90's when these vessels operated more globally against a background of competition in a low-cost economy. Post 2000 the focus on more stringent verification was adopted, leading to reduced number of incidents and casualties. However, the trend is not continuing to reduce in the past 5 years.

This paper focusses on Liftboat safety and comparison with Jack-ups because of the similar characteristics. There are some main differences in operation compared to Jack-ups (no cantilever drilling, different structural design) and on the other hand activities are alike. Therefore the question rises, to what extend should we be following similar processes?

This paper does not provide answers, however does provide an overview of recent and past incidents. Weak spots are identified by showing the incidents are identical to Jack-up incidents and deserve as much attention for assessment, installation, operation and transit.

KEY WORDS: Liftboat, Self Elevating (Work Over) Platform SEWOP, Jack-up, Stability, Guideline, Incidents.

ABBREVIATIONS:
LB Liftboat, JU Jack-Up, MODU Mobile Offshore Drilling Unit, SEP Self Elevating Platform, O&G Oil and Gas, USCG U.S. Coast Guard, RPD Rack Phase Difference, MOM Marine Operation Manual, SSA Site Specific Assessment.

INTRODUCTION

This is an update on an article 20 years ago from Oil & Gas Journal on how Liftboats (LB's) evolved from a small to a large fleet, moving into deeper water, becoming multi-functional and increasingly used in O&G. Best described in [1] "The Liftboat Industry – before and after regulations" (1999). The original LB design was not at all ambitious. An easy deployable work vessel that would provide support for the fixed platforms in the Gulf of Mexico. Nevertheless, the modern LB is different from its original design and purpose.

Based on the accident and fatality rates, it appears that there is lack of clear guidance for robustness checks on LB's. For MODU Jack-Up's (JU's) this is recognized, and clear industry standards are available. Nonetheless, incidents with JU's continue to occur on a rate that is considered high. The most recent overview of JU incidents categorized per phase of operation (I. tow, II. moving-on/off location, III. on-site), is summarized in [2] 2013. For LB's similar accident statistics are observed.

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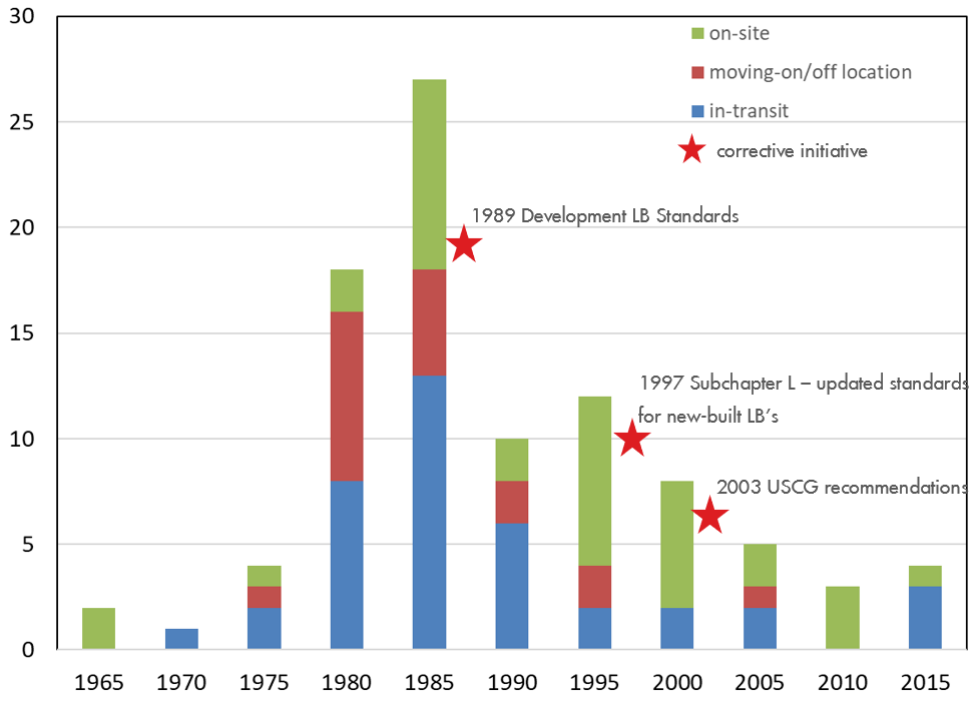
The difficulty with incident statistics is that not all incidents are reported. However, efforts are made to keep summary of incidents to investigate and learn. The graph below shows the number of LB incidents that have been reported or were observed. The total number of (known) incidents is 94 of total loss in the period 1965 to 2019, which on average is nearly 2 per year. The graph presents incidents per 5-year period and noticeable is that the number was high in the 1980s, mainly because the industry was in full swing and memorable wreckage caused by hurricane Juan in1985. Important corrective initiatives to reduce the number of incidents and regulate are:

1) Initiative from the U.S. Coast Guard (USCG) led to developing Standards for LB's in 1989 [3].
2) More verification by means of inspection and safety recommendations enforced by Navigation and Vessel Inspection Circulars (NVIC[1]) and National Transportation Safety Board (NTSB [4] 1991).
3) In September 1997, the Shipping Code of Federal Regulation issued Subchapter L – Offshore Supply Vessels as the standard for new-built LB's. More restrictive than former standards.
4) Through the USCG, the Subcommittee on LB Operations, reported in April 2003 to the National Offshore Safety Advisory Committee (NOSAC) with instructive recommendations such as:
    a. Examine operation manual's description on preload procedures;
    b. Review shipyard contracts (on quality control language);
    c. Encourage information sharing between involved parties;
    d. Operation procedures (stability, preload) and "dealing with punch-throughs".



Liftboat Total Losses = 94 (period 1965 to 2019)

Some of the recent incidents have been extracted and tabulated below.

[1] A Navigation and Vessel Inspection Circular (NVIC) provides detailed guidance about the enforcement or compliance with a certain Federal marine safety regulations and Coast Guard marine safety programs.

Company - Vessel	Location	Incident
Montco Offshore - Juan	US GoM	Dec 28th 2006: Punch-through created a 10 deg list. Worsening weather causing capsize and eventually to sink. Vessel was salvaged to a shipyard, back in service Oct 2007.
Sinopec - Shengli #3	Bohai China	Sept 7th 2010: Rig capsize 34 rescued 2 fatalities.
Trinity LB Services - Trinity II	Mexico GoM	Sept 8th 2011: Disabled during tropical storm Nate. Ten POB abandoned vessel 6 rescued 4 fatalities.
Hercules - Starfish	US GoM	Sept 30th 2011 : Capsized after it was struck by "multiple waterspouts". Five evacuated and then rescued from sea.
Hercules - Mako	Nigeria	Jan 16th 2012: Engulfed by fire from KS Endeavour at Chevron.
Warren George - Katherine G	US New York	April 6th 2012: Capsize during construction activities at Statue of Liberty.
Shoreline VII	Nigeria	June 20th 2012: Loss of station-keeping; well services operations.
Seb Orion	Brazil	Oct 6th 2012: Capsize after punch-through.
Saudi Aramco - Arabiya-4	Saudi Arabia	Dec 27th 2013: Rig collapse in Safaniya field 27 POB 3 fatalities.
A2Sea - Sea Worker	North Sea	Jan 27th 2016: towing connection lost, grounded and declared total loss.
Ezion - Tera Lyza	South China Sea	June 5th 2018: Developed sudden list during tow and then capsized.
Aries Marine - RAM XVIII	US GoM	Nov 19th 2018: Vessel loss of stability (45-degree list) during tow 19 POB evacuated.
OMC - AJ Bourg	Nigeria	March 6th 2019: Vessel capsized due to loss of stability whilst underway in squall - 30 POB, 28 evacuated 2 fatalities.

As an example, the above-mentioned Trinity II incident was openly investigated. The referenced paper [5] discusses the Trinity II deficiencies and the ethical duties of a registered engineering company to correct deficiencies and to inform unaware future owners.

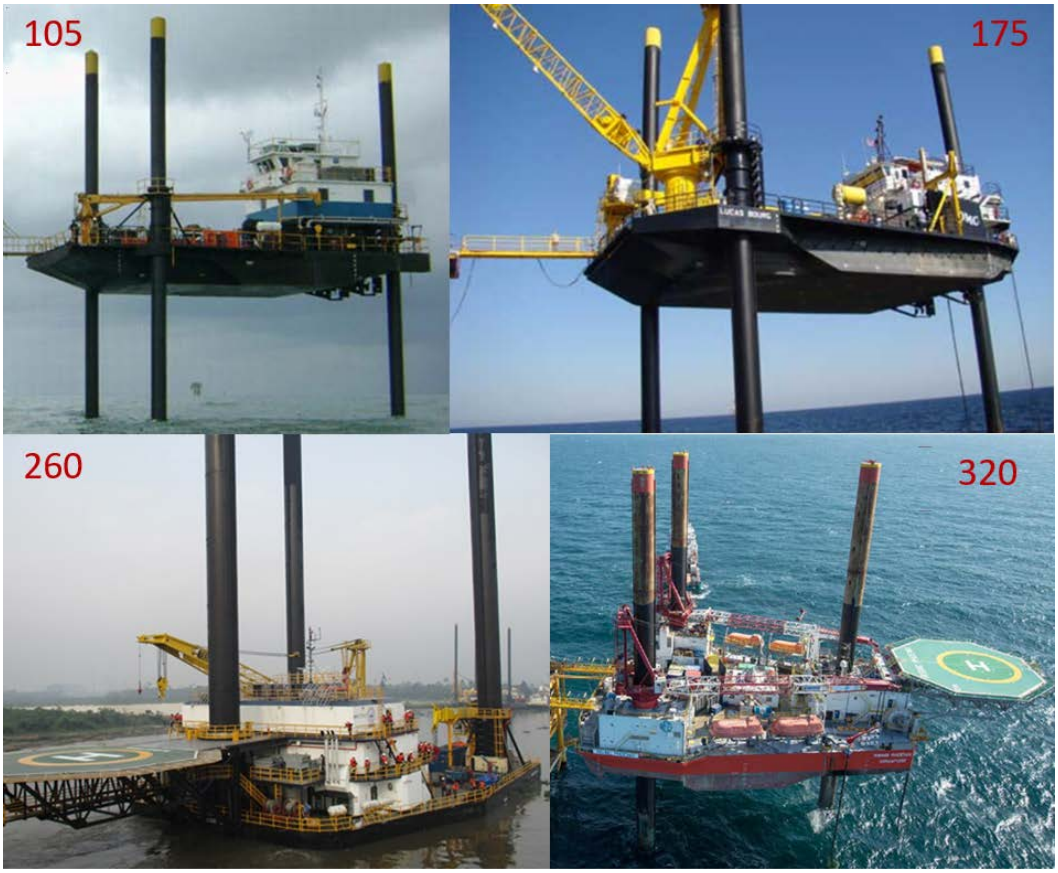
From the available data it is concluded that the number of incidents has not decreased in the last 5 years. Most LB incidents appear to occur "in transit" and "on-site". For JU's a significant number of incidents occurs during "moving-on/off". The differences between LB and JU incidents could be explained by the following:

- Different preload requirements and capability;
- Deeper water / harsher environment for JU's (exposure to wind in otherwise benign environments);
- Leg design: trussed versus tubular, sensitivity to RPD and punch-through.

Limited literature exists on LB stability and spudcan fixity [6, 7], and the above incident summary leads us to the question, is the SSA applied for LB's? To some extent this will be discuss in the following sections.

LIFTBOAT SPECIFICS

Perhaps the first question to address is what is a LB? In general, a LB is characterized by the following: self-propelled, no cantilever, tubular legs, equipped with crane and available deck space. The industry tends to use LB classification by the length of the legs, ranging from 105 to 320 ft. Examples of LB Class 105, 175, 260 and 320 are shown below. The real question is, when do we differentiate between a LB and JU? It could be argued that a vessel with over 300 ft legs, capable of working in water depths up to circa 40m, is no longer a LB.



Liftboat examples - internet gathered pictures

The LB's referred to in this paper have 3 legs and therefore differ from SEP with typical 4 legs [8]. With 3 legs, similar to JU's, the soil capacity is "tested by preloading" with ballast water. A general overview of comparisons between LB and JU are summarized in the table below. Besides leg length, other basic characteristics are identified which give more insight on safeguarding for storm loading stability and soil interaction.

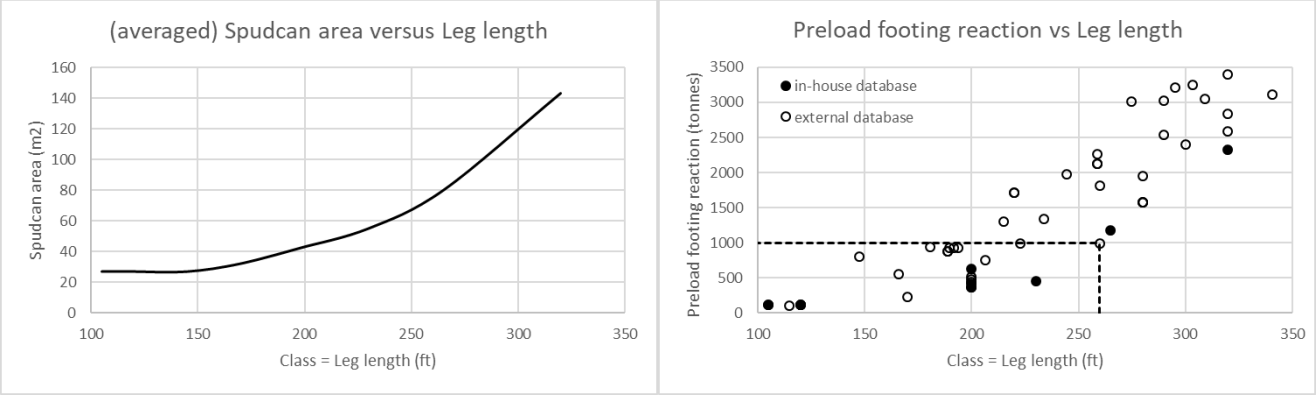
LB's have tubular legs and pads, as opposed to trussed legs and spudcans for JU's. They sail in an opposite direction compared to JU's which are towed. Combining the footing area and preload footing reactions, an interpretation on required spudcan-soil bearing capacity is made in the last column. These bearing capacities are low for LB's compared to JU's. This is because a LB is designed for moving swiftly on and off site, whereby the leg penetrations remain shallow to assist leg extraction.

Unit / size		Leg Length (ft)	Leg O.D. (inch)	Pad / spudcan area (m^2)	Preload footing reaction (mt) [3]	Spudcan bearing capacity (kPa)
LB	S	100-160	48	25	100	10
	M	160-220	48-66	35-55	150-500	10-20
	L	220-280 [1]	66-108	55-75	300-600 [2]	20-30
JU	S	>300	tubular / trussed	150	4000	40-60
	M	design specific	trussed	150-250	7 to 10.000	60-80
	L	design specific	trussed	250-350	10 to 20.000	80-100

Notes 1) upper range rated to 320 ft on www.liftboats.com.
2) based on database trends, an upper range for capable preload footing reaction should be 1500-2500 rather than 600 mt (metric tonnes) as illustrated on graphs below.
3) Preload footing reactions are excluding leg buoyancy and including spudcan buoyancy.

The LB interaction with the soil can be graphically presented showing the following:

- averaged Spudcan (pad) area versus Leg length
- Preload footing reactions versus Leg length



Graphical presentation of Liftboat footing specification

Based on above interpretation of data, "technically" LB's can be distinguished from JU's based on the following specifications:

- Leg length is less than 260 ft;
- Preload footing reactions are below 1000 tonnes;
- Required soil bearing capacities remain below 30 kPa, according to the rule of thumb:

$$\frac{(Preload\ footing\ reaction\ \times 10)}{(spudcan\ area\ \times 6)}$$

SITE SPECIFIC ASSESSMENT (SSA)

As any other offshore asset, JU's are safeguarded by performing assessments with verification of appropriate environmental loading conditions including safety factors. ISO prescribes the Site Specific Assessment of Mobile Offshore Units – Part 1: Jack-ups in ISO 19905-1 [9]. Theoretically LB's fall under the same requirement for manned units and installed at an offshore site, certainly when installed alongside an O&G platform. To assess the rig stability, besides soil conditions and operational load, metocean conditions are carefully selected for robustness checks. For manned non-evacuated operations, the following primary checks are mandatory for a JU to pass:

- omni-directional 50-year return period, all-year independent extremes of wave, wind and current, or,
- omni-directional 100-year combined joint-probability values.

In some cases, either wave directionality can be incorporated, or seasonal metocean criteria may be permitted if deemed appropriate.

JU's can withstand the severe storm loading because they are required to operate in harsh offshore environment. Therefore, industry does not rate JU's for their leg length, but for their typical design, as it represents the ability to withstand loading conditions typical for offshore regions. Spudcan-leg design, hull-leg interface, jacking mechanism and preloading capability, are main rig specifications that play an important role in the overall stability. The hazards associated with towing JU's are managed by the application of Marine rules and regulations.

For exposure to hurricanes the industry has learned lessons the hard way and most Operators no longer allow JU's to operate in these regions, unless the rules for safe and timely evacuation is managed by means of reliable weather forecasting.

For LB's, the environmental loads should be applied according to the same principles, noting that typically these extremes are milder, because of the regions where operated are shallower water with limited wave heights. As

known to most readers of this paper, preload is an important specification for demonstrating the soil is sufficiently load-tested by exceeding the highest expected storm load. As alluded to in the previous section, the LB designs per "Class", i.e. leg length, appear not to be rated to a consistent level for preload footing reaction. LB's need to be site specifically assessed and preloaded to appropriate level. In some cases, this means that the site characteristics and load combination exceed the capability of LB's with marginal preload capability.

UNDERSTANDING RECENT INCIDENTS

If we attempt to explain the recent LB accidents, one interpretation is that Marine transit requires more inspection. Perhaps the self-propelled ability makes people more relaxed about stability during transit. However, LB Marine Operation Manuals (MOM) are clear about the poor sailing performances. With the legs fully raised, winds combined with 4-6 ft waves can already cause green water on deck. This means that reliable weather forecasts are required and in case of being caught out in bad weather, as instructed by the MOM, the legs need to be lowered or the vessel brought to a nearby safe haven.

The other phase where LB incidents are high is 'on-site', which can be explained as follows:

- LB's with 'low' preload / stability capability should not be selected for a shallow water site with any non-benign metocean conditions;
- In the past a trend was observed where LB's were not verified for applying the (full) preload according to either vessel specification or an assessed SSA level. It is unclear if this performance has improved and is verified;
- Sailing LB's are not stable for high wind speeds.

Technically there is a dilemma for a LB in the situation where the SSA results show exceedance of unity checks, and at the same time it cannot sail away safely because of floating stability issues due to high wind and waves. This situation may occur in regions prone to 'squalls'. LB's are popular for operations in the shallow waters of West Africa and this is an area known for squalls.

The definition of squalls for West Africa region (as derived from in-house Metocean Reference Documents): Brief periodic events of high and rapidly changing winds and locally rough waves are caused by line squalls. These disturbance lines are normally oriented North/South and move westward with typically 50-60 km/hour There are massive banks of clouds accompanied by heavy rain, lightning and thunder. Peak gusts occur soon after the leading edge of the squall passes, and the peak gusts are typically 20-25 m/s (40-50 knots) although extremes above 35 m/s (70 knots) have already been observed. The squall usually passes in an hour or two, with gradually diminishing winds. The squall season is also well defined. Most squalls occur in the 5-month period February to June and in October-November.

The last factor, that undoubtfully has the highest influence on incidents, is the experience of onboard personnel. In general, it can be said that LB personnel involved with stability are more experienced than JU personnel, simply because LB moves are more frequent. The tubular legs are stiff and can, to a certain extent, take load caused by sliding, settlement or controlled punch-through. Adequate corrective actions after a storm may prevent actual damage and incidents.

CONCLUSION

The number of Liftboat incidents can and must be reduced further. Important lessons can be learned from the past and taking a closer look at the regulations developed for Jack-ups. Each of the three operational phases – I. in-transit, II. Moving-on/off location, III. on-site – is as important for overall safety performance. A Liftboat cannot be allowed on a site if it the transit route is unsafe. Additionally, the operation on-site must be validated with adequate stability / robustness checks.

Even if the costs are attractive, a Liftboat is not the straightforward preference for selection if operations are outside the capability. A site assessment should be performed to check robustness, involving all parties. Hereby, there must be upfront communication with the Liftboat owner on data sharing from the vessel operation manual.

This data needs to be combined with the site data, including the metocean environmental conditions during transit.

This paper encourages the community to consistently gather data from project experiences and share learning in similar ways the Jack-up community has developed.

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