CONSOLIDATED RISK Inc. Houston Texas

Comparative Analysis
Methods and Systems for Descent to Sea
for Life Raft Based Escape Systems

FOR

RISK SAFETY SYSTEMS US. Inc

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Risk Safety Systems US Inc.

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Life Raft Escape To Sea – Comparative Analysis of Available Systems

Document Title

Life Raft Escape To Sea – Comparative Analysis of Available Systems

Project No.	Document No.	Sheet
CR 100013		1 of 29

TABLE OF CONTENTS

1 Introduction

1.1 Background

Consolidated Risk is a Safety/risk and loss control consulting company based in Houston, Texas. Consolidated Risk (CR) offers Safety/Risk consulting services and risk/loss control based engineering design services for the upstream oil and gas industry. http://www.consolrisk.com

Specializing in offshore fixed and deepwater/floating production systems, Consolidated Risk has considerable experience in providing consulting services and advice to a broad range of operators and contractors worldwide, both upstream and downstream with a proven record of accomplishment of increasing safety, availability, and profitability for our clients

Listed below are a sample of projects for which CR have provided safety, risk management, and/or loss control consulting support:

- **BHP Shenzi - TLP GOM HSE.**
  HSE Coordinators managing full safety case including QRA and various safety studies

- **Encana Deep Panuk.**
  Full loss prevention support for MODEC bid for Canadian development with high concentrations of H2S

- **Chevron Frade FPSO.**
  Full loss prevention design support for SBM IMODCO

- **SMB IMODCO Exxon Mobil Yoho FSO.**
  On-project as HSE consultant to SBM providing full range of qualitative analysis study work; including FRA, EERA, ESSA, Heli and Ship Collision Analysis, Dropped Object Analysis

- **Conoco Magnolia – TLP GOM**
  On-project role, managing all HSE and Loss Control design for the Topsides, including HSE & Safety Design Philosophies, Fire Risk Analysis, Fire Water System design, Fire & Gas System design, Emergency Equipment Layouts, & interface with USCG & ABS for topsides safety engineering issues

- **SBM IMODCO – Chevron Kuito 2A FPSO.**
  Provided Loss Control support, including preparation of Emergency Equipment & Escape Route Drawings, deluge system design and Cost /Schedule Risk analysis.

- **Husky – White Rose FPSO.**
  Produced Fire Water Deluge design philosophy and system design

- **Chevron Sanha Project – FPSO West Africa.**
  Carried out full Quantitative Risk Analysis of FPSO at FEED stage to establish baseline risk profile

- **Conoco West Natuna Belanak FPSO Project**.
  Employed as Conoco Risk & Loss Control consultant for duration of the project, from pre-concept selection through FEED and into detailed engineering Deliverables included all HSE and Loss Control Philosophies, FERA, HAZOP, HAZID, Dropped Object study, QRA, and general on project safety engineering support

- **Sable Offshore Energy Development - Petro Canada**
  Contracted to manage HSE issues for KBR for detailed engineering, interfacing with CNSOPB, and Lloyds Register to ensure legislative and certification compliance for HSE for the field development Also carried out program of safety studies, including FERA, EERA, dropped Object Heli-crash, HAZID, HAZOP all summarized in Safety case document.

Consolidated Risk offers two main areas of consulting support:

- Design Safety/HSE/ QRA
- Loss Control/ Fire Protection

Typical Safety/HSE/QRA support services include:

- Safety Case Preparation
- Direct client Support
- Close on-project Risk Support
- Client Representation with Legislative/Certifying Authorities
- Risk Based Concept Selection
- Concept/Preliminary or detailed engineering/operations HAZID
- Concept/Preliminary or detailed engineering/operations HAZOP
- Concept/Preliminary or detailed engineering/operations QRA
- Development of Health & Safety Management System
- Environmental Planning & Policy
- Definition of HSE Philosophy
- Risk Based Verification
- Definition of Safety Critical Elements
- Definition of Performance Standards
- Development & Management of Safety Concerns Database
- Fire & Explosion Risk Analysis
- Escape Evacuation & Rescue/Recovery Analysis
- Heli-operations Risk Analysis
- Dropped Object Analysis
- Marine Collision Risk Analysis Smoke & Gas Migration/ingress Analysis
- TR Integrity Analysis

Typical Loss Prevention support services include:

Fire Protection

- Fire water & deluge system design
- System design philosophies
- Fire water P&ID design
- Fire protection layouts
- Equipment specification
- MTO
- PFP/fire & blast wall specification

Emergency Equipment

- Emergency equipment specification
- MTO
- Location & layout design
- Lifeboat specification
- Emergency/survival equipment specification

Fire Detection

- Fire & gas system design
- System design philosophies
- Fire & gas layouts
- MTO
- Equipment specification
- Equipment lists

Additional Specialist Techniques

Whilst not exhaustive, the tools and methods described above represent the majority of the approaches that are available to calculate and quantify risks. These tools and skills are customized to specific industries and can be highly effective in enhancing profitability by identifying areas of high-risk exposure. Additionally CR can supply external audit and PEER Review expertise to evaluate projects for facilities for compliance with Corporate, Legislative, Class or any other HSE requirements.

1.2 Definitions

Description	Definition
Access Route	See Egress Routes
Abandonment	The act of personnel onboard leaving an installation in an emergency.
EER	Evacuation Escape and Rescue. A general term used to describe then range of possible actions including egress, muster, refuge, evacuation, recovery, escape to the sea and rescue.
Embarkation Area	A place from which personnel leave the installation by evacuation e.g. a heli deck and associated waiting area or a lifeboat station.
Egress	The act of personnel moving away from a hazard to a place where its effects are reduced or removed.
Egress Route	Any route from any area of an installation to a muster area, embarkation area or means of escape to the sea.
Evacuation	The planned method of leaving the installation in an emergency without personnel entering the sea. The result of an evacuation is the transfer of personnel to a safe location or vessel.

Description	Definition
Evacuation Route	An escape route leading from a temporary refuge to an embarkation area.
Muster Area	A designated area where personnel report when required to do so.
Primary Method (Evacuation)	A method which can be carried out in a fully controlled manner under the direction of the person in charge (OIM). It is also the preferred method of leaving the installation and should be a normal method of arriving / leaving it.
Recovery	The process by which those who have entered the lifeboats or life rafts are retrieved to a place of safety.
Rescue	The process by which those who have entered the sea are retrieved to a place where medical assistance is available.
Secondary Method (Evacuation)	A method which can be carried out in a fully controlled manner under the direction of the person in overall charge (normally the OIM).
Temporary Refuge (TR)	One or more locations where personnel will adequately protected from relevant hazards while they remain on an installation following an uncontrolled incident.
Tertiary Method (For escape)	A method which relies considerably on individual action and a fully controlled operation under the control of the person in charge cannot be assumed. When used to leave the installation, it is likely to require personnel to enter the sea.

2 Objectives

Tertiary methods of escape from a facility are those which rely considerably on individual actions of the personnel on board. They are utilized when a fully controlled operation under the control of the person in charge (OIM) cannot be assumed. This would be likely to be an event of catastrophic proportions that would require immediate escape from the facility. Access to the TR or the TEMPSC' stations may be unavailable requiring personnel to leave the facility by whatever means they can access. When tertiary methods are used to leave the facility, it often requires personnel to enter the sea.

When calculating the fatality contributions for any installation the immediate fatality contributions are first established (fatalities resulting from the initial accident event). The next category of fatality contributions are those associated with the act of evacuating the installation under controlled or uncontrolled conditions. In this context this may be defined as under the organized supervision of a person in charge (OIM) or acting on individual initiative when the primary muster area or evacuation systems (TEMPSC) are not available. By reference to table 1.1 below it can be seen that EER fatality contributions for various types of facilities pose a significant fraction of the overall fatality risks.

Table 1.1 Comparison of Facility EERA PLL

Comparison of Diverse Facility EERA PLL					
Facility	Facility Type	Immediate	EER	EER as a % of Immediate	EER as a % of total FE risk
South Arne	GBS	1.36E-02	9.42E-03	**69%**	**41%**
Thebaud	Jacket	3.29E-02	1.59E-02	**48%**	**33%**
North Triumph	Jacket	5.74E-04	1.96E-04	**34%**	**25%**
Venture	Jacket	2.70E-03	5.58E-04	**21%**	**17%**
Belanak FPSO	FPSO	9.90E-02	3.30E-02	**33%**	**25%**

Ref: [1] Conoco Phillips Belanak FPSO Development Project Quantified Risk Analysis.

Therefore, the issue of EER risks should be carefully considered when defining evacuation and escape philosophies and equipment for offshore systems.
With this issue in mind, the objective of this study is to carry out a comparative evaluation of the methods and systems currently in use for situations where an organized evacuation cannot be undertaken, and personnel are required to resort to alternative (tertiary) devices.

The evaluation is intended to provide a qualitative comparison of the methods and systems currently utilized by the offshore industry for tertiary escape when the primary evacuation system is not available. The current assumption for the industry is that the TEMPSC (Freefall or Davit launched) are designated 'primary,' while helicopters are designated 'preferred.' This definition is based on the premise that while the preferred method of leaving the facility is by helicopter, it is acknowledged that under a major accident event requiring evacuation the

TEMPSC will be the primary available method (helicopters cannot operate in smoke & heat/flame conditions).

The evaluation will consider each system against a number of categories using a range of currently utilized industry standard Performance Standards/requirements for the operation of tertiary systems.

3 Basis for the Study

Consolidated Risk have been contracted by Risk Safety Systems Inc., a Houston based safety equipment manufacturing & supply company to carry out a comparative analysis of the methods and equipment currently available for tertiary escape from an offshore installation. In this context tertiary escape is defined as:

"A method which relies considerably on individual action and a fully controlled operation under the control of the person in charge cannot be assumed. When used to leave the installation, it is likely to require personnel to enter the sea."

Tertiary methods and equipment to be evaluated are as follows:

a) Throw over Life Raft in Stand- Alone Configuration

This may be defined as a deck mounted life raft located in a cradle which is deployed by throwing overboard and inflated via painter line. Access to the life raft once deployed may be via knotted rope, rope ladder, rope net, fixed ladder, or personal descent device (Donut)

b) Davit Launched Life Raft

This may be defined as a deck mounted semi-rigid life raft located in a cradle which is deployed by a dedicated davit. The system is designed such that personnel enter the life raft before deployment to sea level. Access to the life raft once deployed may be via knotted rope, rope ladder, rope net, fixed ladder, or personal descent device (Donut).

c) Escape Chute with Open Netted Chute Configuration.

This is usually comprised a skid mounted system with life rafts, chute, debarkation raft and stabilizing system packed into a container assembly and deployed by releasing the system at deck level. Once deployed the system falls to sea where the debarkation raft inflates and life rafts float freely attached to the debarkation raft by their painter lines. Personnel enter the chute and zigzag through the netted sections down to sea level where they exit the chute and deploy the life rafts. Once inflated the crew pull-in the life rafts and cross board to evacuate the installation.

d) Escape Chute with Closed Chute Configuration.

This is usually comprised a skid mounted system with life rafts, closed chute, debarkation raft and stabilizing system packed into a container assembly and deployed by releasing the system at deck level. Once deployed the system falls to sea where the debarkation raft inflates and life rafts float freely attached to the debarkation raft by their painter lines. Personnel enter the chute through a three layer fire protected column, controlling their descent by use of elbows and knees. The chute ends at approximately four feet above sea level where personnel exit the chute onto the debarkation raft. The crew then pull-in the life rafts and cross board to evacuate the installation.

The purpose of this evaluation is to provide an objective comparison of the relative merits of the methods and systems based on the following categories:

1. Ease of Use (Practicality)
2. Safety
3. Capital Costs (CAPEX)
4. Reliability
5. Maintainability (OPEX)

1. Ease of use.

a) Is the system easy to deploy (how many steps for deployment?)
b) Does the system require a dedicated user in order for it to be used?
c) Is the system easy to use (can all crew be trained to operate it)?
d) Does the system rely on personal initiative for successful operation?
e) Does the system manage fear of heights, vertigo, claustrophobia etc.?
f) Can injured or disabled personnel use the system?

2. Safety

a) Does the system protect personnel from smoke, flames, heat while descending to sea level?
b) Are personnel required to enter the sea?
c) Does the system allow personnel to use it wearing life vests/survival suits?
d) Is there a weight limit for individuals using the system?
e) Are the materials of construction suitable for the application?

3. Capital Costs (CAPEX).

a) Relative Costs (how does the system compare top the other options?)

4. Reliability.

   a) Is the system simple or complex?
   b) Is the system based on proven technology?
   c) Does the system have any known problems or failure modes?
   d) Is there any redundancy in the system?

5. Maintainability (OPEX).

   a) What is its maintenance schedule?
   b) Does the system require frequent attention?
   c) Are specialist services required to maintain the system?
   d) What are the spares holding requirements?

Weighting the categories.

In order to achieve a qualitative comparison of the relative merits of the alternatives under consideration each of the categories have been weighted and scored to develop an overall score comparison. The categories have been weighted as follows:

Table 3.1 Weighting Factors

Category	Weighting Factor %
1. Ease of Use (Practicality)	20
2. Safety	30
3. Capital Costs (CAPEX)	10
4. Reliability	20
5. Maintainability (OPEX)	20
TOTAL	100

These weighting factors were applied using an excel spreadsheet to evaluate each category and their subsets discretely. The objective is to develop a qualitative score of each system under each of the five categories.

The results of the evaluation are presented in section 4.0 together with conclusions concerning the relative merits for each system. Appendix 'A' presents the detailed worksheets for each category.

4. Results & Conclusions

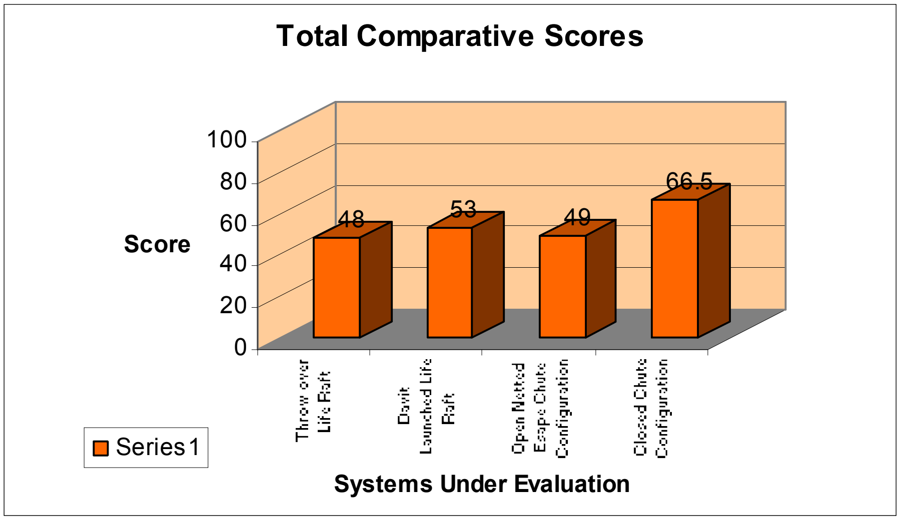
4.1 Results

Table 4.1 below illustrates the results of the assessment of the four systems under evaluation.

Table 4.1 Results Comparative Assessment of Life Raft Systems

Review Category	Cat #	Throw over Life Raft in Stand- Alone ConfigurationCategory Totals	Davit Launched Life Raft Category Totals	Escape Chute with Open Netted Chute Configuration. Category Totals	Escape Chute with Closed Chute Configuration Category Totals
Ease of Use	1	12	12	14	14.5
Safety	2	6	22	14	23
Capital Costs (CAPEX)	3	8	3	4	6
Reliability	4	6	10	9	12
Maintainability (OPEX)	5	16	6	8	11
	Totals	48	53	49	66.5

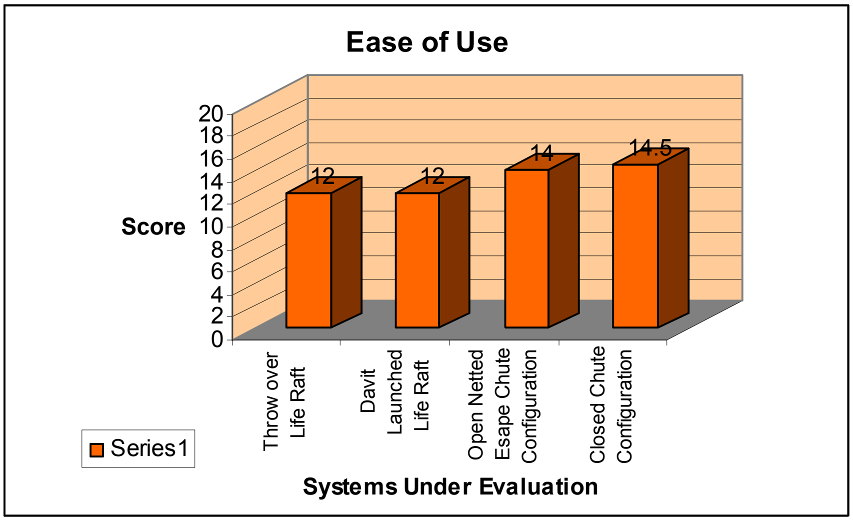
Figure 4.1 Total Comparative Score



As can be seen the closed escape chute system scores highest overall followed by the davit launched life raft, netted escape chute system and stand alone life raft. The reasons for these results are discussed by category in the following sections and summated in the conclusions section of this report.

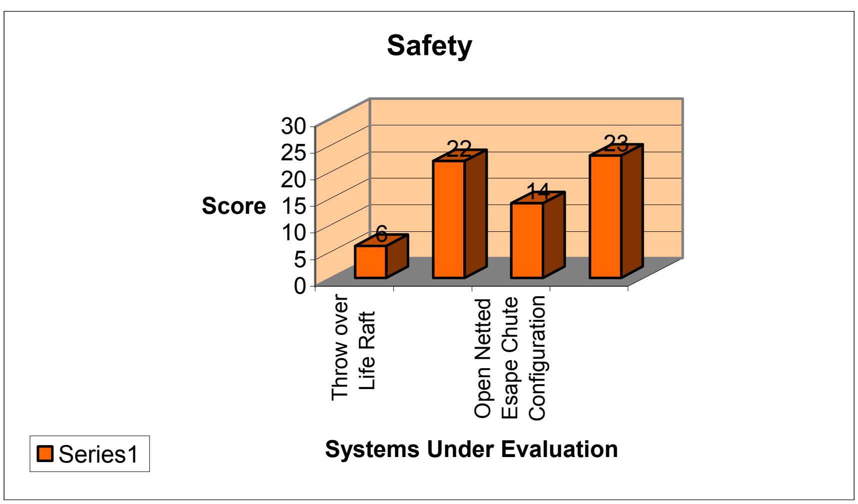
When evaluating the results based on category the results are as follows:

3.1.1 Ease of Use



For the Ease of use category the two escape chute systems score highest with the closed chute slightly higher than the netted chute. This is primarily due to the slightly more complicated requirement for personnel to use the netted chute system.

3.1.2 Safety

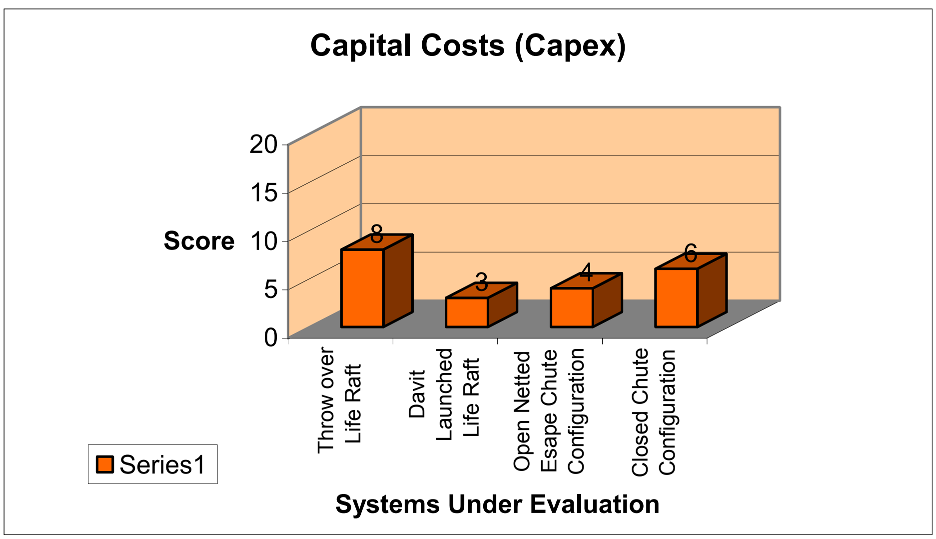


For the Safety category the closed chute system scores best overall followed closely by the davit system. This is due to the protection offered by both the closed chute system and the davit launched life raft as personnel traverse to sea level.

For the open netted escape chute very little protection is afforded personnel as they attempt to descend to sea rendering them less safe in a major hazard event than the davit or closed chute.

The least safe by a considerable margin is the stand alone life raft. This is understandable as the arrangements available with this option for personnel traversing from the deck down to the raft at sea level are very poor and rely heavily on the physical fitness of the individual attempting to use them.

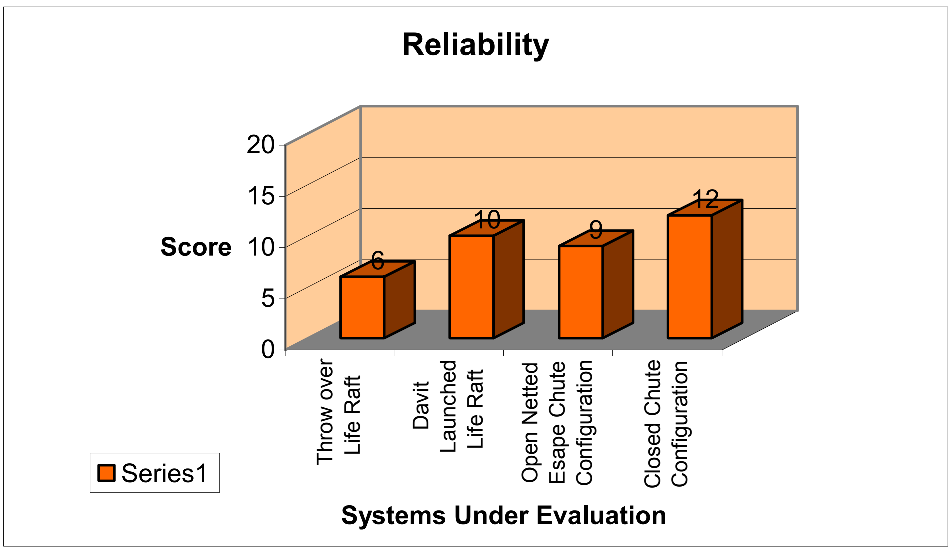
3.1.3 Capital Costs (CAPEX)



When considering capital costs, the stand alone life raft scores highest overall. This is due to the greater costs associated with the other more complex systems. However the second best system under this category is the closed chute escape chute system which scores a six as opposed to the open netted system four. Ostensibly this may seem erroneous however the netted chute system is offered commercially by a single vendor and is priced considerably higher than most alternative escape chute systems currently available.

The davit life raft system scores lowest due to the complexity of equipment however this may be inaccurate when compared to the largest and most complex netted chute system which would likely cost considerably more than the davit system (costs for the highest specification netted chute system rivals that of a davit launched TEMPSC).

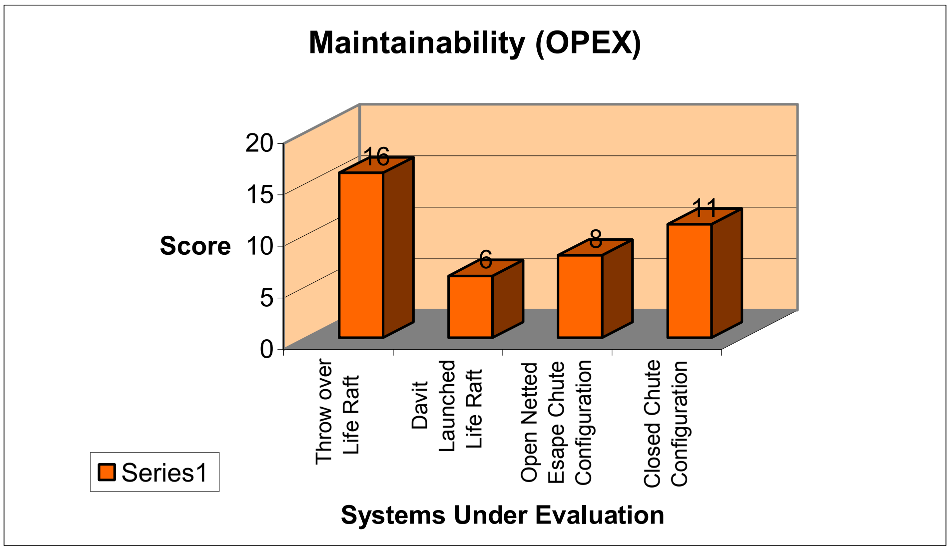
3.1.4 Reliability



When evaluating reliability the closed chute system again scores highest followed by the davit life raft system. The closed chute system scores highest primarily due to the simplicity of the system while the davit system score on proven technology. The netted chute is only marginally lower than the davit system based on the need for personnel to maneuver themselves through the system thus increasing the potential for getting stuck.

The stand alone life raft when evaluated without this means of access once deployed would score highly however its overall reliability is low as the available means to access it are poor with a high likelihood of injury or fatality.

3.1.5 Maintainability (OPEX)



For maintainability, the stand alone life raft scores the highest. This is due in main to the low complexity of the system. The closed escape chute scores second highest followed by the netted chute system. This is due primarily to the scale and complexity of the full specification netted system which is comprised a complex system of cables, winches enclosures and is extremely large and cumbersome as compared to the lighter and less maintenance heavy closed chute system.

The davit launched life raft scores the lowest due to the complex davit & winch arrangements which require a level of maintenance and intervention considerably greater than the other systems.

The results are summarized collectively below in table 4.2 for comparison.

TITLE: **Life Raft Escape To Sea – Comparative Analysis of Available Systems**

Table 4.2 Summary of Results

		Throw over Life Raft in Stand- Alone Configuration	Davit Launched Life Raft	Escape Chute with Open Netted Chute Configuration.	Escape Chute with Closed Chute Configuration.
1	**Ease of Use**				
1a	Is the system easy to deploy (how many steps for deployment?)	4	2	3	3
1b	Does the system require a dedicated user in order for it to be used?	4	1	3	3
1c	Is the system easy to use (can all crew be trained to operate it)?	3	1	3	3
1d	Does the system rely on personal initiative for successful operation?	1	3	2	2
1e	Does the system manage fear of heights, vertigo, claustrophobia etc.?	0	1	1	1
1f	Can injured or disabled personnel use the system?	0	4	2	2.5
	Total	12	12	14	14.5
2	**Safety**				
2a	Does the system protect personnel from smoke, flames, heat while descending to sea level?	0	2	0	8
2b	Are personnel required to enter the sea?	1	6	5	5
2c	Does the system allow personnel to use it wearing life vests/survival suits?	2	6	3	4
2d	Is there a weight limit for individuals using the system?	1	4	2	2
2e	Are the materials of construction suitable for the application?	2	4	4	4
	Total	6	22	14	23
3	**Capital Costs (CAPEX)**				
3a	Relative Costs (how does the system compare top the other options?)	8	3	4	6
	Total	8	3	4	6
4	**Reliability**				
4a	Is the system simple or complex?	3	2	4	5
4b	Is the system based on proven technology?	2	6	4	3
4c	Does the system have any known problems or failure modes?	0	2	1	4
4d	Is there any redundancy in the system?	1	0	0	0
	Total	6	10	9	12
5	**Maintainability (OPEX)**				
5a	What is its maintenance schedule?	6	1	3	4
5b	Does the system require frequent attention?	5	1	2	4
5c	Are specialist services required to maintain the system?	2	2	2	2
5d	What are the spares holding requirements?	3	2	1	1
	Total	16	6	8	11

4.2 Conclusions

The results of this study indicate that of the four systems and methods evaluated the closed chute escape chute system offers the best overall option for tertiary evacuation facilities from an offshore installation.

This is due to the high scores attained for ease of use, safety, and capital costs, reflecting the relative simplicity of the system to deploy and traverse, the safety afforded the individuals as they traverse the chute to sea level and the costs when compared to the davit and netted chute systems.

The next highest scoring system is the davit launched system. This is because though the system scores lower for ease of use, capital cost and maintenance, its scores well for safety and reliability (it affords protection for personnel descending to sea level and is proven technology).

The netted escape chute system is third and scores poorly on safety and capital costs. This is due to the lack of protection afforded the crew as the traverse from the deck to sea level and considerable cost for the system. While the netted chute scores better for ease of use, its performance overall is evaluated less effective than the davit or closed chute systems.

Finally, the lowest scoring system is the stand alone life raft which scores worst of all on safety and reliability. This is due entirely to the poor options currently available for the crew to traverse from the deck to sea level once the raft has been deployed. Though this system scores best on maintenance it is overall the least preferable option for tertiary evacuation from an offshore facility.

In conclusion, when evaluated on ease of use, price, reliability/maintainability and perhaps most importantly on safety the closed chute escape chute system is preferred equipment when compared to the other systems currently available.

END OF REPORT

4 APPENDICIES

4.1 APPENDIX 'A' Comparative Analysis of Systems

4.2 APPENDIX 'B' Stand Alone Life Raft – Typical Arrangement

4.3 APPENDIX 'C' Davit Launched Life Raft – Typical Arrangement

4.4 APPENDIX 'D' Netted Escape Chute System– Typical Arrangement

4.5 APPENDIX 'E' Closed Column Escape Chute System– Typical Arrangement

APPENDIX ‘A’

Comparative Analysis of Systems

TITLE: Life Raft Escape To Sea – Comparative Analysis of Available Systems

	Comparative Analysis Methods and Systems for Descent to Sea for Life Raft Based Escape Systems	Rating			Weighting	Throw over Life Raft in Stand-Alone Configuration	Rating	Davit Launched Life Raft	Rating	Escape Chute with Open Netted Chute Configuration.	Rating	Escape Chute with Closed Chute Configuration.	Rating
		Max	Mean	Min	%								
1	1. Ease of Use (Practicality)				20								
1a	Is the system easy to deploy (how many steps for deployment?)	4	2	0	4	Easy deployment, release straps remove hand rail kick over side of Installation. Liferaft will inflate when its painter line is pulled.	4	Complex system requires locks and sdafeguards to be removed	2	More complex than throw over liferaft but less than davit launched liferaft	3	More complex than throw over liferaft but less than davit launched liferaft	3
1b	Does the system require a dedicated user in order for it to be used?	4	2	0	4	No dedicated user required. Simple operation. All crew uis trained to same standard.	4	Requires individual significant training to operate.	1	Requires some training, but far less that Davit Liferaft	3	Requires some training, but far less that Davit Liferaft	3
1c	Is the system easy to use (can all crew be trained to operate it)?	3	1.5	0	3	Yes! Simplist of all options	3	Most complicated to use of all options	1	Relatively easy to use, all persons onboard can be trained to use this system.	3	Relatively easy to use, all persons onboard can be trained to use this system.	3
1d	Does the system rely on personal initiative for successful operation?	3	1.5	0	3	Yes! Once the liferaft is deployed accessing the liferaft at sealevel relies on personal initiative and fitness.	1	No, once trained personnel load and deploy no personal initiative is required for the crew onboard.	3	Yes, persons are required to traverse the chute and exit onto floatation platform at the b bottom. Some guidance and command and control is exercised by personnel managing the process.	2	Yes, persons are required to traverse the chute and exit onto floatation platform at the b bottom. Some guidance and command and control is exercised by personnel managing the process.	2
1e	Does the system manage fear of heights, vertigo, claustrophobia etc.?	2	1	0	2	No persons attempting to access the throw over must traverse to sea by ropes, nets, personal descent devices, or fixed ladders. The likelihood of safe descent to sea is low. Though personal descent devices are safer the sensation of hanging in space is un	0	Partially, once the crew are inside the davit launched liferaft they cannot easily see outside. However the single connection to the davit results in a swinging sensation that can be unsettling for many crew.	1	Though traversing to sea inside a netted chute the individual can see outside the column and is subjected to a clear view of the sea below and facility above. The sensation can be very unnerving for personnel with height related issues.	1	Personnel enter the chute column and are totally enclosed until exitong the bottom. While this may benefit personnel with height issues any individuals with claustrophobia will be very unnerved.	1

TITLE: Life Raft Escape To Sea – Comparative Analysis of Available Systems

1f	Can injured or disabled personnel use the system?	4	2	0	4	No, once the liferaft is deployed it requires a great deal of physical effort to descend to sea. Any injury or disability would render the individual unable to descend unaided. Practically, the only option would be for the injured to be lowered by rope or	0	Yes, onve carried or lifeted onto the raft they can descend on the davits	4	Injured personnel can use the system but it will require some dexterity to negotiate the zigzag sections o0f the chute. Totally disabled persons will not be able to use the syste.	2	Partially disabled persons would be able to use the chute provided they can control their descent with use of arms or legs. Persons unconciouss or totally disabled wiould require lowering down the chute on a stretcher	2.5
2	**Safety**				**30**								
2a	Does the system protect personnel from smoke, flames, heat while descending to sea level?	8	4	0	8	No, descent is via ladder rope ladder rope net or other unprotected means	0	No, descent is via davit so liferaft is vulnerable to direct impinging flame, some or heat flux as it is lowered to sea. Persons onboard ar afforded partial protection by the raft.	2	No, netted chute arrangement does not ptotect against smoke heat or flame. Persons overcome in the chute column will bottleneck the system and defeat the evacuation process	0	Yes the closed chute system offers full protection for persons traversing the chute until they arrive at the floatation raft at sea level. Protection is achieved by a three concentric layer chute system with an inner traversing chute center structural chu	8
2b	Are personnel required to enter the sea?	6	3	0	6	Yes, persons accessing a throw over liferaft will enter the sea and attempt to swim to the raft.	1	No the raft detaches on contact with the sea and floats free with personnel inside.	6	Dependent upon the model personnel will generally exit the chute onto a floatation platform at sea level and then transfer over to the liferaft.	5	Dependent upon the model personnel will generally exit the chute onto a floatation platform at sea level and then transfer over to the liferaft.	5
2c	Does the system allow personnel to use it wearing life vests/survival suits?	6	3	0	6	Yes, but the need to descend via rope, ladder or other means requiring high fitness level hampers personnel when wearing bulky or heavy gear.	2	Yes, personnel board at deck level	6	Yes but the zigzaging through the sections as the individual descends to sea with bulky equipment is rendered quite demanding.	3	Yes, very little additonal effort is required on the part of the crewmember as they descend directly down the column controlling their descent using elbows and knees.	4
2d	Is there a weight limit for individuals using the system?	6	3	0	6	No, but heavier persons attempting to descend to sea will be unable to support thewor bodyweight and have a high risk of falling to sea.	1	No the weight is controlled by the max persons allowed to use the raft. This poses a disadvantage whren compared to the chute options which can move many more persons to liferafts more quickly and do not require so many rafts.	4	Yes max is approx 250lbs.	2	Yes max is approx 250lbs.	2
2e	Are the materials of construction suitable for the application?	4	2	0	4	Liferaft is suitably constructed and rated. The current weakness is in the methods and materials availabe to access the rafts once it has vbeen deployed.	2	Yes. System is cerftified and approved for use for a given number of personnel	4	Yes. System is cerftified and approved for use for a given number of personnel dependent upon the liferafts supplied with the system.	4	Yes. System is cerftified and approved for use for a given number of personnel dependent upon the liferafts supplied with the system.	4

TITLE: Life Raft Escape To Sea – Comparative Analysis of Available Systems

3	**Capital Costs (CAPEX).**				**10**								
3a	Relative Costs (how does the system compare top the other options?)	10	5	0	10	The stand alone liferaft with rope or ladder access is a relatively inexpensive option for tertiary escape. However the cost is dependent upon the number of pesonnel required to escape using this method.	8	Davit launched systerm is expensive to purchase due to the complexity of the system (davits winches, etc.)	3	For reasons not entirely clear the netted chute system (only one vendor offers this a s a complete system) is relatively expensive to purchase when compared to the closed chute option or stand alone liferaft. It is somewhat comparable in capital costs to	4	The closed chute system compares very favorably to the netted chute and davit system but is somwhat more expensive that the stand alone liferaft.	6
4	**Reliability.**				**20**								
4a	Is the system simple or complex?	6	3	0	6	The liferaft itself is a simple system with proven reliability. However the methods available for access to the raft once it has been deployed to sea are very unreliable and sucessful use is very dependent upon the fitness level of the individuals attempt	3	The davit system is the most complex of the option evaluated and requires specific training to operate.	2	The netted system is easy to deploy and use requiring no particular training over that of the average crew member. It is slightly more complicated to navigate than the closed chute system in that it requires the user to maneouver their bodies in a particu	4	Theclosed chute system is easy to deploy and use requiring no particular training over that of the average crew member. The crew member descends directly and exits the chute at sea level onto the floatation raft.	5
4b	Is the system based on proven technology?	6	3	0	6	The raft offers proven technology, however the use of ropes and ladders is not proven in actual evacuation conditions.	2	The davit system is proven system with an extensive track record of sucessful use.	6	The netted chute has been utilised within the offshore oil and gas industry for approximately 15 years. However it has not been demonstrated during actual evacuation.	4	The closed chute is a relatively nes system and has not been utilised within the offshore oil and gas industry for very long. It has not been demonstrated during actual evacuation.	3
4c	Does the system have any known problems or failure modes?	4	2	0	4	Yes, though the throw over liferaft is in itself reliable, the means of access to sea currently used are primitive and prone to fail unless the individual is etremely fit.	0	Though the davit susystem is proven the additional complexity of the launch system (davits winches etc.) introduce a greater potential for failures on demand.	2	Yes, the lack of fire protection for personnel traversing the column can result in incapacitation or death of personnel within the chute if exposed to flame smoke or high heat flux. Once an individual in the column is incapacitated the evacuation system f	1	No significant known problems or failure modes. Once personnel eneter the column they are protected from flame, heat or smoke until they exit the chute at sea level at which point they cross into the liferaft and depart.	4
4d	Is there any redundancy in the system?	4	2	0	4	None unless more than one raft are stored together. However it is unusual for an operator to located two rafts adjacent to eachother unless they are required to service the total amount of personnel that both can accommodate (i.e. no redundancy as only ha	1	None each system is designed and installed to accommodate/evacuate a given compliment of crew.	0	None, if the chute system fails no evacuation can occur from that system.	0	None, if the chute system fails no evacuation can occur from that system.	0
5	**Maintainability (OPEX).**				**20**								

TITLE: Life Raft Escape To Sea – Comparative Analysis of Available Systems

5	**Maintainability (OPEX).**				20								
5a	What is its maintenance schedule?	6	3	0	6	Low maintenance requirements.	6	High maintenance requirements for complex system	1	Relatively low maintenance requirements for basic system. System requires removal every five years. Routine inspection by facility operator. Complex system requires more intensive maintgenence due to complexity of system (blast rated enclosure winches etc	3	Relatively low maintenance requirements. System requires removal every five years. Routine inspection and lube by facility operator	4
5b	Does the system require frequent attention?	6	3	0	6	No. System only requires periodic visual inspection for damage, missing equipment.	5	Maintenence intervals and schedules are highest of systems evaluated due to comlexity of the system.	1	Periodic routine visual inspection by facility operator required. Complex system requires more frequent maintenence due to complexity of system (blast rated enclosure winches etc.) Also failure potential; is higher for more complex system.	2	Routine inspection and lube by facility operator only.	4
5c	Are specialist services required to maintain the system?	5	2.5	0	5	Yes, rafts must be serviced by accredited agent or individual.	2	Yes, system must be serviced by accredited agent or individual.	2	Yes, system must be serviced by accredited agent or individual.	2	Yes, system must be serviced by accredited agent or individual.	2
5d	What are the spares holding requirements?	3	1.5	0	3	None required.	3	Some spare should be stored to minimise unavialiability of the system during operations	2	None, vendor only able to repair or service. This can result in extended period of unavilability should the system be demonstrated to be faulty. However due to the designn of the system any fault or failure may only be revealed on demand.	1	None, vendor only able to repair or service. This can result in extended period of unavilability should the system be demonstrated to be faulty. However due to the design of the system any fault or failure may only be revealed on demand.	1