بسم الله الرحمن الرحيم

∞∞∞

تم رفع هذه الرسالة بواسطة / حسام الدين محمد مغربي

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات : لا يوجد

FIRE RISK ASSESSMENT FOR MOBILE OFFSHORE PRODUCTION UNIT (MOPU)

By

Mohamed Ahmed Mohamed Abdellatif

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
INTERDISCIPLINARY - MASTER OF SCIENCE
in
RISK ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

FIRE RISK ASSESSMENT FOR MOBILE OFFSHORE PRODUCTION UNIT (MOPU)

By

Mohamed Ahmed Mohamed Abdellatif

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
INTERDISCIPLINARY - MASTER OF SCIENCE
in
RISK ENGINEERING

Under the Supervision of

Prof. Dr. Fouad Khalaf

Professor of Petroleum
Department of Mining Petroleum and Metallurgical Engineering,
Cairo University

Dr. Zeyad Mohamed Rezk

HSE Assistant General Manager, Petroleum Gas Company

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

FIRE RISK ASSESSMENT FOR MOBILE OFFSHORE PRODUCTION UNIT (MOPU)

By

Mohamed Ahmed Mohamed Abdellatif

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
INTERDISCIPLINARY - MASTER OF SCIENCE
in
RISK ENGINEERING

Approved by the Examining Committee

_____

Prof. Dr. Fouad Khalaf Thesis Main Advisor
Professor of Petroleum
Department of Mining Petroleum and Metallurgical Engineering,
Cairo University

_____

Dr. Zeyad Mohamed Rezk Advisor
HSE Assistant General Manager, Petroleum Gas Company

_____

Prof. Dr. Tharwat Waziri Abou Arab Internal Examiner
Professor of Heat Engines and Combustion
Cairo University

_____

Dr. Tarek Mohamed Abdelhamid External Examiner
Partner of Green company for Environmental Studies and Services

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2022

Engineer's Name: Mohamed Ahmed Mohamed Abdellatif
Date of Birth: 01/03/1988
Nationality: Egyptian
E-mail: eng_mohamedlatif@hotmail.com
Phone: 01001774832
Address: Haram, Giza, Egypt

Registration Date: 1/10/2015
Awarding Date: / /2022
Degree: (Master of Science)
Department: Risk Engineering

Supervisors: Prof. Dr. Fouad Khalaf
Dr. Zeyad Mohamed Rezk

Examiners: Prof. Dr. Fouad Khalaf (Thesis main advisor)
Dr. Zeyad Mohamed Rezk (advisor)
HSE Assistant General Manager Petroleum Gas Company
Prof. Dr. Tharwat Waziri Abou Arab (Internal examiner)
Dr. Tarek Mohamed Abdelhamid (External examiner)
Partner of Green company for Environmental Studies and Services.

Title of Thesis:

FIRE RISK ASSESSMENT FOR MOBILE OFFSHORE PRODUCTION UNIT (MOPU)

Key Words:

Risk Assessment; Jet fires; Pool fires; Risk analysis; event tree analysis

Summary:

The study assesses the fire and explosion impacts at the (MOPU) mobile offshore production unit from the hydrocarbon releases (including blowouts) at the MOPU and the bridge linked WHP (wellhead platform). It does not include releases from the subsea pipelines and the FSO (Floating Storage and Offloading) which is stationed at a safe distance from the MOPU and WHP.

The study utilizes DNV Phast 8.22 and Aloha software simulation to accommodate the future trends within risk analysis in an industry, where quantification of risk is legally required. A generic and representative offshore installation setup is developed as a test environment, including drawings, process streams, process sections and a representative manning setup.

Case studies test the model capabilities and are discussed in relation to the selected software platform, hydrocarbon consequence modelling and uncertainty. The results support the potential of this project's model at this stage of development and presents, how the use of Aloha software is able to increase the expert's confidence in the results by improved post processing compared to the DNV Phast 8.22 software results.

As a result, it was acknowledged that the both software's DNV Phast 8.2 and aloha are almost giving the same results, but the DNV Phast gives more and accurate results.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Mohamed Ahmed Mohamed Abdellatif Date: / /2022

Signature:

Acknowledgments

In the name of Allah, the most gracious and the most merciful, all prayers to Allah for the strengths and his blessing in completing this thesis.

I would like to express my gratitude and appreciation to Prof. Dr. Fouad Khalaf and Dr. Ziad Rezk for their kind guidance. I also thank Eng. Reem Said and Mr. Mohammed Boukhatro at the Risk Engineering Master's Program for their support and help.

I would like to express my sincere appreciation and gratitude to my family for their help, support, patience, and words of encouragement during the preparation of this thesis.

Table of Contents

List of Tables

List of Figures

Nomenclature

Acronyms	Description
AFFF	Aqueous Film Forming Foam
ABS	American Bureau of Shipping
API	American Petroleum Institute
ADES	Advanced Energy Systems
BOSIET	Basic Offshore Survival Induction and Emergency Training
CMPT	Centre for Marine and Petroleum Technology
DNV	Det Norske Veritas
EERA	Escape Evacuation and Rescue Analysis
EPIRB	Emergency Position Indicating Radio beacon
ERP	Emergency Response Plan
ESSA	Emergency Systems Survivability Analysis
EGPC	Egyptian General Petroleum Corporation
ESD	Emergency Shutdown
FB	Full Bore
FERA	Fire and Explosion Risk Assessment
FSO	Floating Storage and Offloading
F&G	Fire and Gas
HAC	Hazardous Area Classification
HAZID	Hazard Identification
HAZOP	Hazard Operability
HLO	Helicopter Landing Officer
HUET	Helicopter Underwater Escape Training
HCRD	Hydrocarbon Releases Database System
HPS	High Pressure System
HSE	Health Safety and Environment
LFL	Lower Flammability Limit
LFHR	Low Frequency High Risk
MAH	Major Accident Hazards
MODU	Mobile Offshore Drilling Unit
MOPU	Mobile Offshore Production Unit
MEDEVAC	Medical Evacuation
OGP	Oil and Gas Producers
OREDA	Offshore Reliability Data
NACE	National Association of Corrosion Engineers
N/A	Not Applicable
NPC	National Petroleum Company
NPC-SAZ	National Petroleum Company – South Abu Zenima
POB	Personal on Board
PPE	Personal Protective Equipment
PS	Performance Standard
PTW	Permit to Work
PZN	Petrozenima
PFP	Passive Fire Protection
P&ID	Process and Instrument Diagram
QRA	Quantitative Risk Assessment
SDV	Shutdown Valve
SSV	Surface Safety Valve
SCE	Safety Critical Element
SOLAS	Safety of Life At Sea
WHP	Wellhead Platform
ISO	International Organization for Standardization

JRA	Job Risk Assessment
UHF	Ultra High Frequency
VHF	Very High Frequency
WHP	Well Head Platform

Symbol	Description
Qo	Initial release rate (kg/s)
CD	Discharge coefficient, typically >0.85 for gas and 0.61 for liquid
A	Hole area (m^2)
Po	Initial pressure of gas (N/m^2)
Z	Square root term
M	Molecular weight of gas (typically 20)
γ	Ratio of specific heats (1.306 for methane)
R	Universal gas constant = 8314 J/kg mol K
T_o	Initial temperature of gas (K)
ρ_l	liquid density (kg/m^3)
P_o	Initial pressure of gas (N/m^2)
Pa	Atmospheric pressure, 105 N/m^2
g	Acceleration due to gravity = 9.81 m/s^2
h	Height of the liquid surface above hole (m)

Term	Definition
Jet fire	A jet or spray fire is a turbulent diffusion flame resulting from the combustion of a fuel continuously released with some significant momentum in a particular direction or directions.
Pool fire	A pool fire is a turbulent diffusion fire burning above a horizontal pool of vaporising hydrocarbon fuel where the fuel has zero or low initial momentum.
Explosion	An explosion is a rapid expansion in volume associated with an extremely vigorous outward release of energy, usually with the generation of high temperatures and release of high-pressure gases.
Blowout	A blowout is the uncontrolled release of crude oil and/or natural gas from an oil well or gas well after pressure control systems have failed.

Abstract

The aim of this thesis is to establish tolerable fire risk assessment for (MOPU) mobile offshore production unit. The event tree technique is used to assess the safety level, to develop an improved specification of the characteristics of the fires that needs to be considered in design and to develop a more accurate system of understanding the failure conditions of vessels under fire loading

The study assesses the fire and explosion impacts at the (MOPU) mobile offshore production unit from the hydrocarbon releases (including blowouts) at the MOPU and the bridge linked WHP (wellhead platform). It does not include releases from the subsea pipelines and the FSO (Floating Storage and Offloading) which is stationed at a safe distance from the MOPU and WHP.

The study utilizes DNV Phast 8.22 and Aloha software simulation to accommodate the future trends within risk analysis in an industry, where quantification of risk is legally required. A generic and representative offshore installation setup is developed as a test environment, including drawings, process streams, process sections and a representative manning setup.

Case studies test the model capabilities and are discussed in relation to the selected software platform, hydrocarbon consequence modelling and uncertainty. The results support the potential of this project's model at this stage of development and presents, how the use of Aloha software is able to increase the expert's confidence in the results by improved post processing compared to the DNV Phast 8.22 software results.

As a result, it was acknowledged that the both software's DNV Phast 8.2 and aloha are almost giving the same results, but the DNV Phast gives more and accurate results.

Chapter 1: Introduction

1.1 Introduction

In fact, petroleum and natural gas are important driven powers of national economic and social development, effectively provide protection of national security, and at the same time, petroleum and natural gas also bring considerable economic income for countries and petroleum companies. In the international background of global oil and natural gas demands, many countries and petroleum companies are actively promoting petroleum and natural gas exploration and development. Current onshore oil resources gradually drying up have been an indisputable fact, 60% annual new oil production is produced from offshore exploration, which makes many countries and petroleum companies full of strong interesting in offshore oil exploration and development. However, offshore oil exploration and development compared with onshore, it has characteristics of harsh environment, complex technology, difficult construction, high investment and high risk, risk not only refer to investment risk and personnel security risk, it also includes downhole risk, equipment risk, environmental pollution risk, petroleum companies also bear more social responsibility, compared to other industries, safety management in offshore oil exploration and development is more complex and important.

The Oil and Gas industry faces tremendous structural changes due to the growing energy demand of emerging countries and the increasingly geological complex reservoirs more difficult to access and exploit. This reality led to innovative technologies and new assessment methods to proper evaluate the drilling risk.

Exploration and extraction of hydrocarbons offshore represents significant engineering challenges. Operating offshore with oil and gas exploration and production does unambiguously require personnel located offshore doing maintenance, process surveillance, catering, and cleaning. The presence of personnel offshore creates a personnel risk, which is unavoidable. Historical events such as the Piper Alpha and the Mumbai High north disaster sustain the fact that severe unforeseen and rare events do occur. However, to accommodate the personnel risk offshore, legal authorities demand that sophisticated risk analyses are performed by the operators to demonstrate that the risk offshore is As Low as Reasonably Possible (ALARP). Lowering a risk offshore is nonetheless costly and is directly affected by the risk criterion limit stated by the operator, to which the risk analysis must comply.

The most dangerous accidents are linked to fire and explosion events and as they may spread quickly through the facility and in some cases vast amount of hydrocarbons are released to the ocean as happened in deep-water horizon accident, On the evening of April 20, 2010, a well event allowed hydrocarbons to escape from the Macondo well onto Transocean’s Deep-water Horizon offshore rig, resulting in explosions and fire aboard. Eleven people lost their lives, and 17 others were injured. The fire, which was