ISOMAse
International Society of Ocean, Mechanical and Aerospace Scientists and Engineers

Journal of Subsea and Offshore
-Science and Engineering-
30th June 2018. Vol.14 No.1
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June 30, 2018

Subsea Pipeline Damaged in Balikpapan Bay Caused by Anchor Load

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Paper History

Received: 20-April - 2018
Received in revised form: 20-June-2018
Accepted: 30-June-2108

ABSTRACT

Balikpapan Bay is an important and dangerous due to five oil subsea pipelines divide the waters of Balikpapan-Penajam Paser Utara to supplied crude oil to Refinery Unit V Balikpapan. In the end of April 2018, one of the subsea pipelines was damaged caused more than 40,000-barrel spill at the Balikpapan bay. It was suspected due to anchor load of a ship. This paper discusses the effect of anchor load on a damaged subsea pipeline in the bay of Balikpapan. In this study, data was collected from many resources and simulated using Subsea Pipeline Pro Software. The simulation results are compared to the field data where the subsea pipeline shifts about 113 meters from its original position by forming V shaped with a degree of 61.

KEY WORDS: *Subsea Pipeline; Damaged; Anchor Load; Balikpapan.*

NOMENCLATURE

BASARNAS	Badan Nasional Pencarian dan Pertolongan
DTT	Daerah Terlarang Terbatas
RU	Refinery Unit
SKPP	Sertifikat Kelayakan Penggunaan Peralatan
ESDM	Energi dan Sumber Daya Mineral
RI	Republik Indonesia
BPSD	Barrels Per Stream Day
BSW	Basic Sediment and Water
Pushidrosal	Pusat Hidrografi dan Oseanografi TNI Angkatan Laut

1.0 INTRODUCTION

Marine pollution caused by the shipping and oil industries is enormous. It was estimated 3.6 million tons of oil spilt into the sea annually, mainly as a result of shipping accidents involving oil tankers and deliberate flushing of tanks and engines as well as offshore and onshore oil well blowouts. The issue of marine pollution has taken an international dimension [1]. The most important pollution in the marine environment and coastal waters therefore is petroleum and its products.

In memorable cases of large scale pollution of the marine and coastal environments by petroleum include such tanker disasters in the North Atlantic sea route as the Torrey Canyon (1967) and the Amoco Cadiz (1978). Over 120,000 and 223,000 tons of crude oil were released into the sea off Cornwell (South West England) and the coast of Brittany (France), respectively [2]. As of March 31, 2018, there has been sea pollution by an oil spill in the bay of Balikpapan as shown in Figure 1. It was suspected that the origin of the oil spill came from Pertamina's subsea pipeline in the bay of Balikpapan due to crashed by a bulk carrier Ever Judger at -1.25824°N 116.78810°E as shown in Figure 2. The location of the sea where there is oil or gas pipeline is essentially a restricted area (DTT). The ship may pass but should not take off the anchor. The DTT area is bordered by a buoy with yellow lights flashing on the edges. This incident led to the death of five fishermen due to crude oil fires in the middle of the Gulf and sea pollution covering an area of more than 12.7 thousand hectares square. This paper investigates the causes of oil spills in the bay of Balikpapan

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Figure 1: Some fire points form a straight line

2.0 Oil Spill in Balikpapan Bay

2.1 RU V Balikpapan

Pertamina as an Indonesian State-Owned Company has built seven refineries throughout Indonesia as listed in Table 1. One of which is Refinery Unit V in Balikpapan with production capacity is 253500 BPSD. The production of Balikpapan refinery is in the form of fuel and non-fuel products, namely premium, kerosene, avtur, diesel oil, fuel oil, heavy naphtha, LPG, LSWR and wax. Figure 2 shows map the PT. Pertamina RU V Balikpapan.

The RU V Balikpapan refinery -1.25254°N 116.82225°E gets crude oil supplied from Lawe-Lawe Terminal -1.33246°N 116.68629°E (A) in North Penajam Paser District which is channeled through pipeline [3] as shown in Figure 1. The transfer pipes are on land and in Balikpapan bay. The transfer pipeline used by Pertamina is still in operation-worthy condition, which is proven by the Certificate of Appropriate Utilization of Equipment (SKPP) issued by the Ministry of ESDM RI and valid until 2019 [7].

Table 1: Production Capacity of PT. Pertamina

Refinery Unit	Province	Production Capacity (BPSD)	%
Pangkalan Brandan (I)	Sumatera Utara	5.000	0.5
Dumai (II)	Riau	170.000	16.3
Plaju-Sungai Gerong (III)	Sumatera Selatan	132.500	12.7
Cilacap (IV)	Jawa Tengah	348.000	33.3
Balikpapan (V)	Kalimantan Timur	253.500	24.3
Balongan (VI)	Jawa Barat	125.000	12.0
Kasim (VIII)	Irian Jaya	10.000	1.0

2.2 Lawe-Lawe Process Plant

When crude oil produced from offshore the crude formation still contains a lot of water, mud, sand and other follow-up that is usually called Basic Sediment and Water (BSW). Water and sediments can cause problems such as plugging, scale formation, erosion and corrosion. For that reason at Lawe-lawe Process Plant is done separation process of oil from element of BSW, so that oil that can fulfill standard of request from refinery unit.

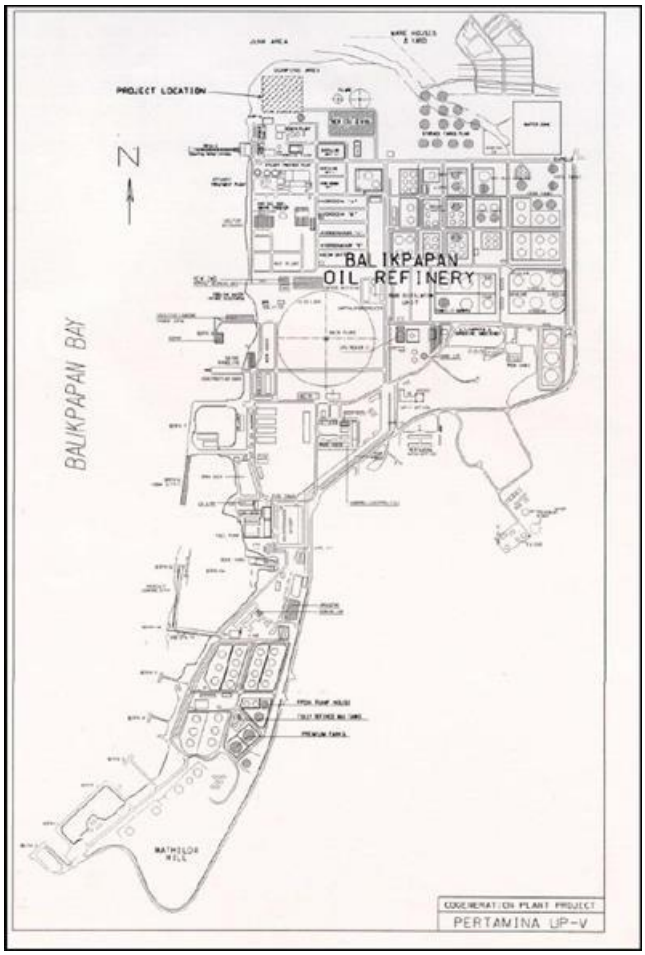

Figure 2: Map PT. Pertamina RU V Balikpapan

In the Lawe-lawe process plant, the crude oil from Sepinggan Production and Yakin Production with pressure ± 150 psig and temperature ±85°F received via pipeline 12 "which met at Tanjung Jumlai. Crude oil goes to Lawe-lawe Process Plant via Pressure Control PC-PL5 which keeps the pressure on ±150 psig, and then through Emergency Shut Down Valve (ESDV) AV-PL4 before finally getting into High Pressure Separator (1001S). In it will be a separation process based on physical properties. Next oil will be flowed towards Crude-Crude Heat Exchanger (901 A / B / C) so that the oil temperature out can rise to ±100°F and the pressure drops to ±70-80 psig. From Heat Exchangers oil is heated inside Direct Fired Crude Heater (501 A/B). Here the oil is heated until the temperature reaches ±150°F, in order to break down the oil-water emulsion so that the following separation process becomes easier. Next is the separation process inside Low Pressure Separator (1000S) with pressure and temperature in the vessel ± 60 psig and ±150°F, then oil flowed to Gas Boot (1003S)

JSOse | Received: 20-April-2018 | Accepted: 30-June-2018 | [(14) 1: 6-12]
Published by International Society of Ocean, Mechanical and Aerospace Scientists and Engineers, www.isomase.org., ISSN: 2442-6415

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International Society of Ocean, Mechanical and Aerospace Scientists and Engineers
Journal of Subsea and Offshore
-Science and Engineering-
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then to Crude Stabilizer Tank (1306B), pressure in a Stabilizer Tank approaching outside air pressure at atmospheric pressure (P_{atm}) so a pump is required to drain the oil from the Stabilizer Tank to vessel next. From Stabilizer, the oil tank is flowed to Horizontal Electrostatic Dehydrator (1007S) to derive the value of BS & W- to meet the standard request. The oil from the saturated Dehydrator is quite high (±140°F) put back to Crude-Crude Heat Exchanger (901 A/B/C) to deliver the heat to the incoming oil of the High Pressure Separator. Further oil is flowed to Storage Tank (1306 C/D) and transported to the refinery unit in Balikpapan through subsea pipeline.

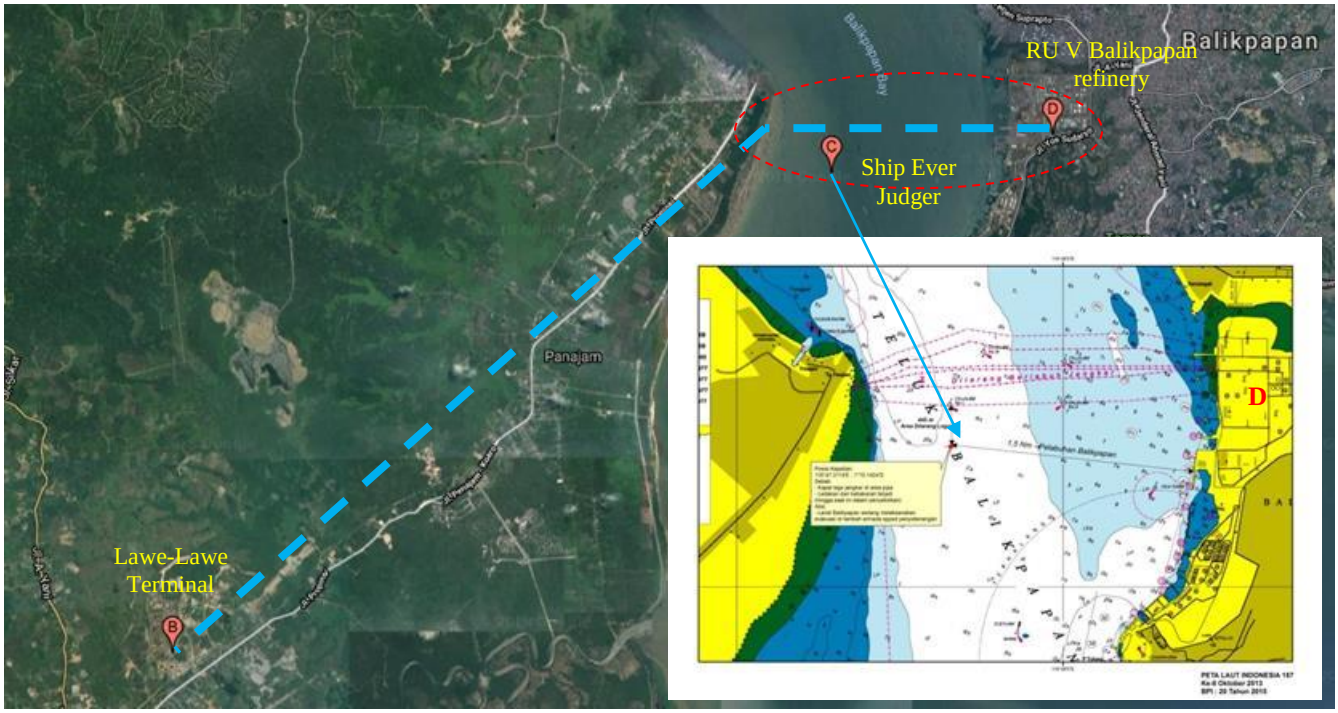

Figure 3: Route of pipeline and position of a suspected ship.

2.3 Subsea Pipeline at Balikpapan Bay

Based on an underwater map issued Pushidrosal, there are 5 oil pipelines that divide the waters of Balikpapan-Penajam Paser Utara [15]. The subsea pipeline was old which is more than 20 years old with graded X42 pipe with a diameter of 508 mm and a thickness of 12.7 millimeters laid on water depth of 22 meters. General specification of the pipeline is shown in Table 1 [4, 6]. The accident location is 3 km away from the RU V refinery, Balikapapan. According to the results of diving by Pertamina, It was known that the pipe was dragged as far as 120 meters from its original position and breaks at a depth of 20-26 meters below sea level. The length of the pipe is approximately 4.5 KM from the Lawe-Lawe Terminal to the Balikpapan Refinery.

Table 1: Specification of subsea pipeline in Balikpapan [4, 6]

Parameters	Unit
Outer Diameter	508 mm
Wall thickness	12.7 mm
Grade	API 5L X42
Maximum Allowable Operating Pressure (MAOP)	1061.42 psig
Water depth	22 m

The Ever Judger has been suspected to drop an anchor in the pipeline area, dragging the pipe and bursting it. The ship Ever Judger is registered in Panama, therefore Panama-flagged. The vessel is also run by a company based in Hong Kong, and its holdings are registered in Cayman Island. The ship is 229.05 meters long, 32.31 meters wide, and 82000 tons deadweight. The vessel is a bulk carrier vessel and comes to Balikpapan to pick up coal and then transfer to Malaysia.

Table 2: Principal dimension of ship Ever Judger

Parameters	Unit
Year Built	2014
Length	229.05 m
Beam	32.31 m
Gross Tonnage (GRT)	44060
Deadweight	82000 Tons
IMO	9632844
MMSI	353036000
Call Sign	3ERQ4
Flag	Panama

JSOse | Received: 20-April-2018 | Accepted: 30-June-2018 | [(14) 1: 6-12]
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The MV Ever Judger ship arrived at the port of Balikpapan at 02.00 WITA and leaned on the pier at 05.55 WITA. The series of events occurred in the early hours of Saturday on March, 31 before 3 am, where it began to detect oil floating in the sea. Previously the new ship finished filling the load of coal as much as 78,000 tons at Jetty Gunung Bayan. The bow of the ship headed east or toward the Makassar Strait to get out of Balikpapan Bay and continue the journey of coal. The ship intends to stop waiting for the tide to easily maneuver out Balikpapan Bay.

The local police stated that the skipper who ordered the first Deck Off to down anchor along 1 shackle. In units of ship anchor size, 1 shackle is 27.5 meters. This was based on records and communication notes between Pilot ship and MV Ever Judger. Other evidence is that the material found at the end of the ship's left anchor is identical to the concrete that wraps around the broken pipe. The pilot ship said that the scene was not an area allowed to remove anchors and was ordered to immediately raise anchors. By that time the ship's engine had been shut down, and the anchor was lifted in a state of the ship still gliding. Weighing 12 tons and stretching chains of 27.5 meters, 5 meters longer than a water depth of 22 meters, left anchor bow is lifted. The anchor is a high dimension of approximately 3 meters and the width of no less than 2 meters, with an estimated weight of 12 tons.

In order to investigate the case, the underwater pipe needs to be lifted to the surface. Implementation of such work required 19 divers to intersect all three pipes by using a Pipe Cold Cutting Machine. Hydro-Oceanographic dive (Hidrosal) diver finds a 498 meter long trench, 1.6-2.5 meters wide, within 0.7-0.4 meters on the ship's pass, and the ditch stops at the anchor point touching the pipe [6]. When the anchor is caught in the pipe, the flexibility makes the pipe attracted until it finally makes the ship stop. Feeling something holding underwater, the ship maneuvered backwards. After that the anchor is free and continues to be lifted. This was shown that the pipeline was found the position of the broken pipeline shifted to the southeast as far as 117.34 from its original position.

3.0 Effect of Oil Spill in Balikpapan to Environment

Indonesia's environment ministry has ordered the oil company Pertamina to clean up a 40,000-barrel spill at the port of Balikpapan, East Kalimantan. The spill continues to affect the bay, with aerial footage showing it has spread across a wide area. The spill is believed to be the worst environmental incident in Indonesia in a decade, with 600 acres of mangrove forests and 18,000 acres of the bay affected. The results of spill analysis of oil spill around Balikpapan coastal area on April 1, 2018, calling oil spill area is 12,987.2 hectares [8]

Oil leaks are estimated to contaminate an area of 7,000 hectares. The length of the affected coast on the side of Balikpapan and Penajam Pasir Utara reaches about 60 kilometers. The affected ecosystem consists of 34 hectares of mangrove plants in Kariangau urban village, and 6,000 mangrove plants and 2,000 mangrove seeds in Kampung Atas Air Margasari.

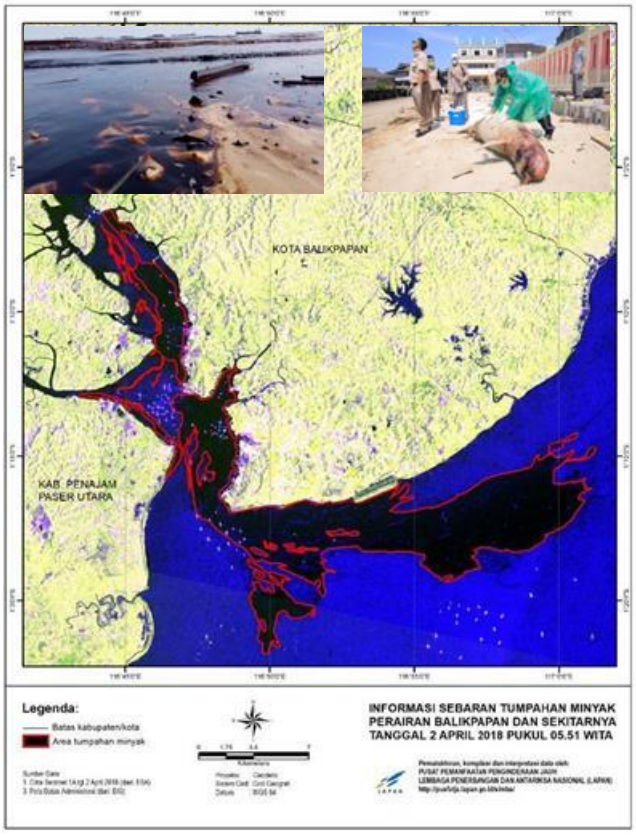

Figure 4: Oil spill around Balikpapan [8].

4.0 RESULT AND ANALYSIS

Subsea Pipeline Software which has been developed by Ocean & Aerospace Research Institute, Indonesia has been used to analyze the collapse, burst, stress and deflection of subsea pipeline due to pulling force by the anchor. Result of simulation shows that the subsea pipeline's collapse, burst and stress was within safety area.

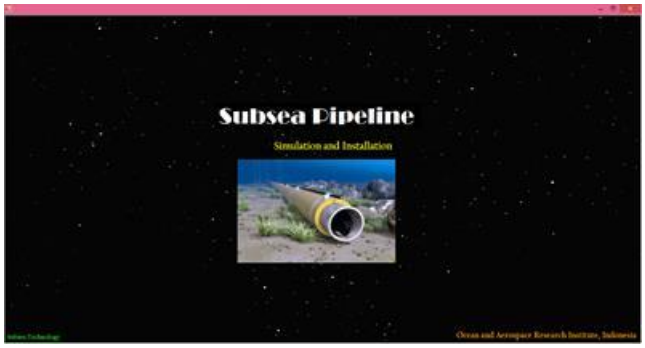

Figure 5: Subsea Pipeline simulation and installation software.

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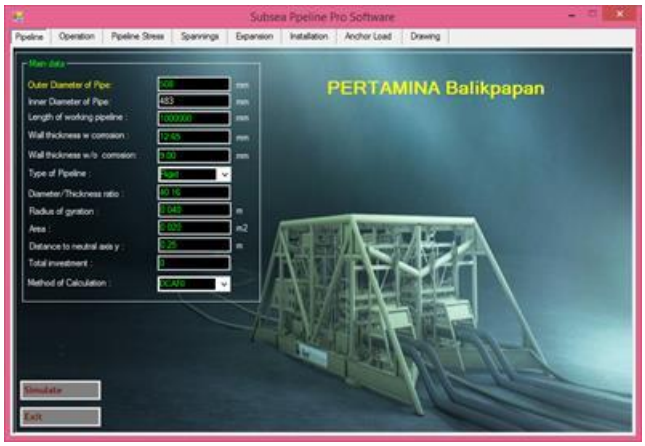

Figure 6: Main principal data of subsea Pipeline

Figure 9: Front view of subsea Pipeline

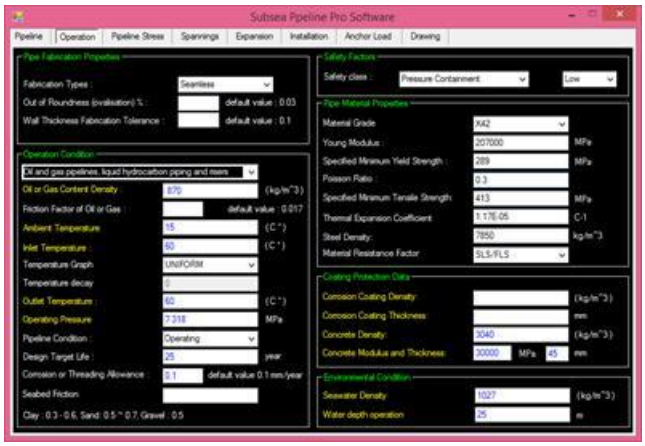

Figure 7: Operation, material properties and environmental data

Figure 10: Anchor effect on subsea Pipeline

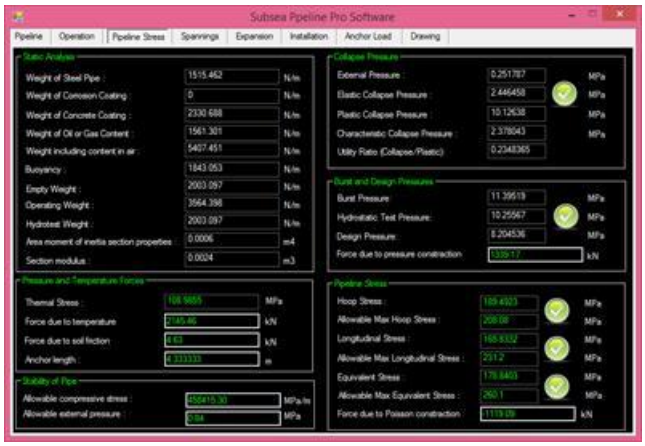

Figure 8: Collapse, burst and stress of subsea Pipeline

After that, the deflection of subsea pipeline due to the anchor should be simulated and compared with the site pipeline. The result simulation shows that at 12 ton force the subsea pipeline deflect 47 degree as shown in Figure 7. In order to find out the truth a damaged underwater pipe must be removed from site for laboratory testing and compared to simulation results. Sea Heaven 2 is a ship used to lift Pertamina's broken pipeline March 31, 2018. Three parts of piece of pipe have been lifted which are each along the 7 meters lifted on 19-April, 2018, 18 meters lifted on 20-Aprril 2018 and last 24 meters lifted on 24-April 2018 as shown in 11.

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Figure 11: Lifting of subsea pipeline from Sea Heaven.

Table 3: Comparison between simulation and site data of subsea pipeline due to anchor load.

Subsea Pipeline	Simulation by Subsea Pipeline Pro	Site data based on Pushidrosal [15]
Form	V Shaped (60 degree)	V Shaped (see Figure 11)
Shifted pipeline	113.61 m	117.34 m
Damaged pipeline	135 m	-

5.0 CONCLUSION

In conclusion, this paper discusses the effect of anchor load on a damaged subsea pipeline in the bay of Balikpapan. Input data was collected from many resources and then simulation using Subsea Pipeline Pro Software. The simulation results show very close to the field data where the subsea pipeline shifted about 113 meters from its original position by forming a V shaped with a degree of 61.

ACKNOWLEDGEMENTS

The authors would like to convey a great appreciation to Ocean and Aerospace Engineering Research Institute, Indonesia and Komuniti Gas Indonesia for supporting this research.

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JSOse | Received: 20-April-2018 | Accepted: 30-June-2018 | [(14) 1: 6-12]
Published by International Society of Ocean, Mechanical and Aerospace Scientists and Engineers, www.isomase.org., ISSN: 2442-6415