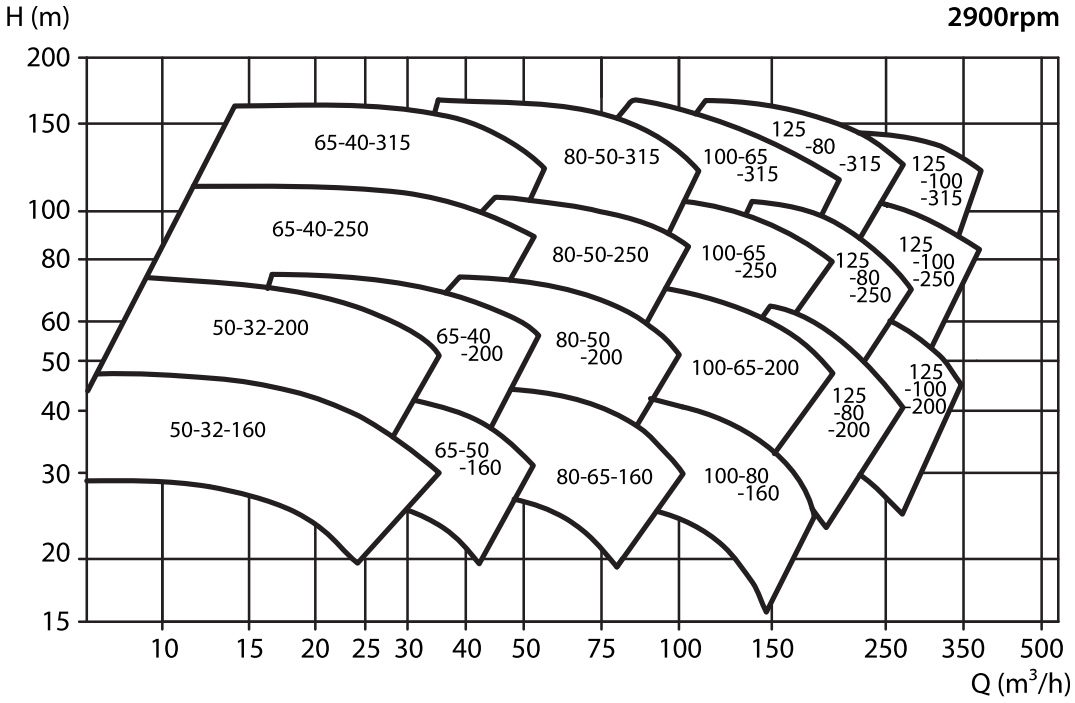
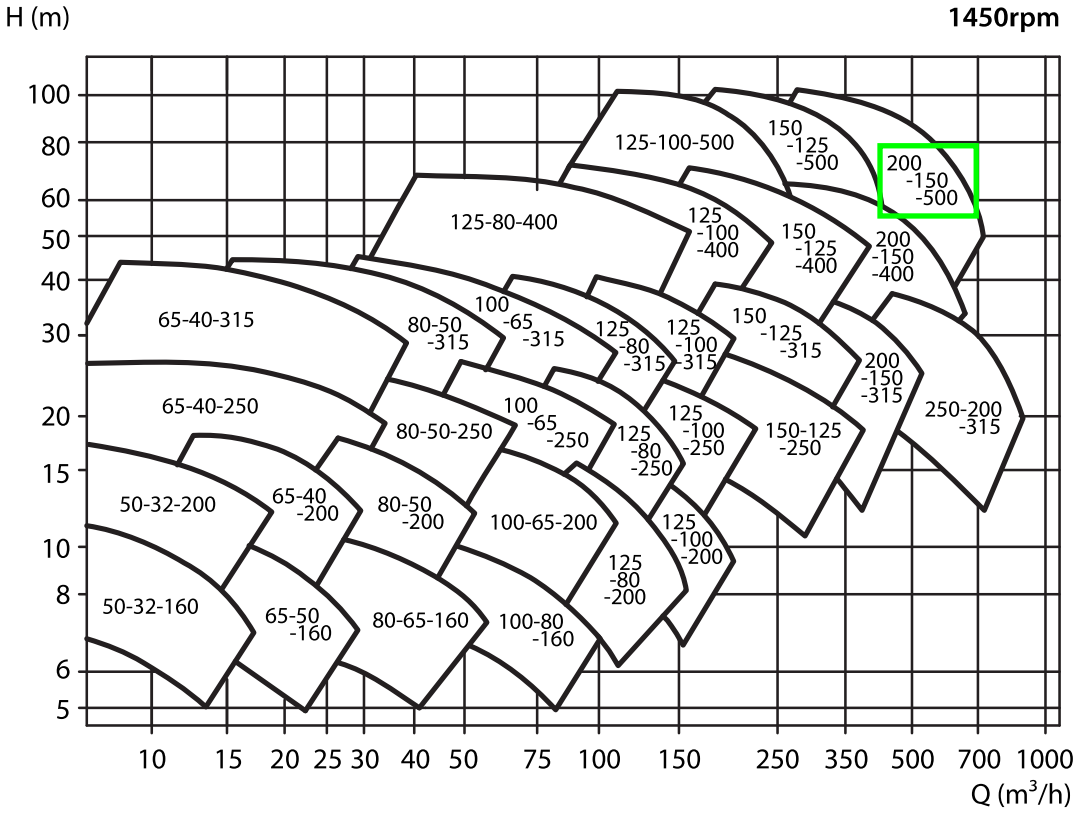
Appendix E. Shore-based (ORF) Fire Water System Details & Hydraulic Analysis

FIELD CHART

EH SERIES 50Hz



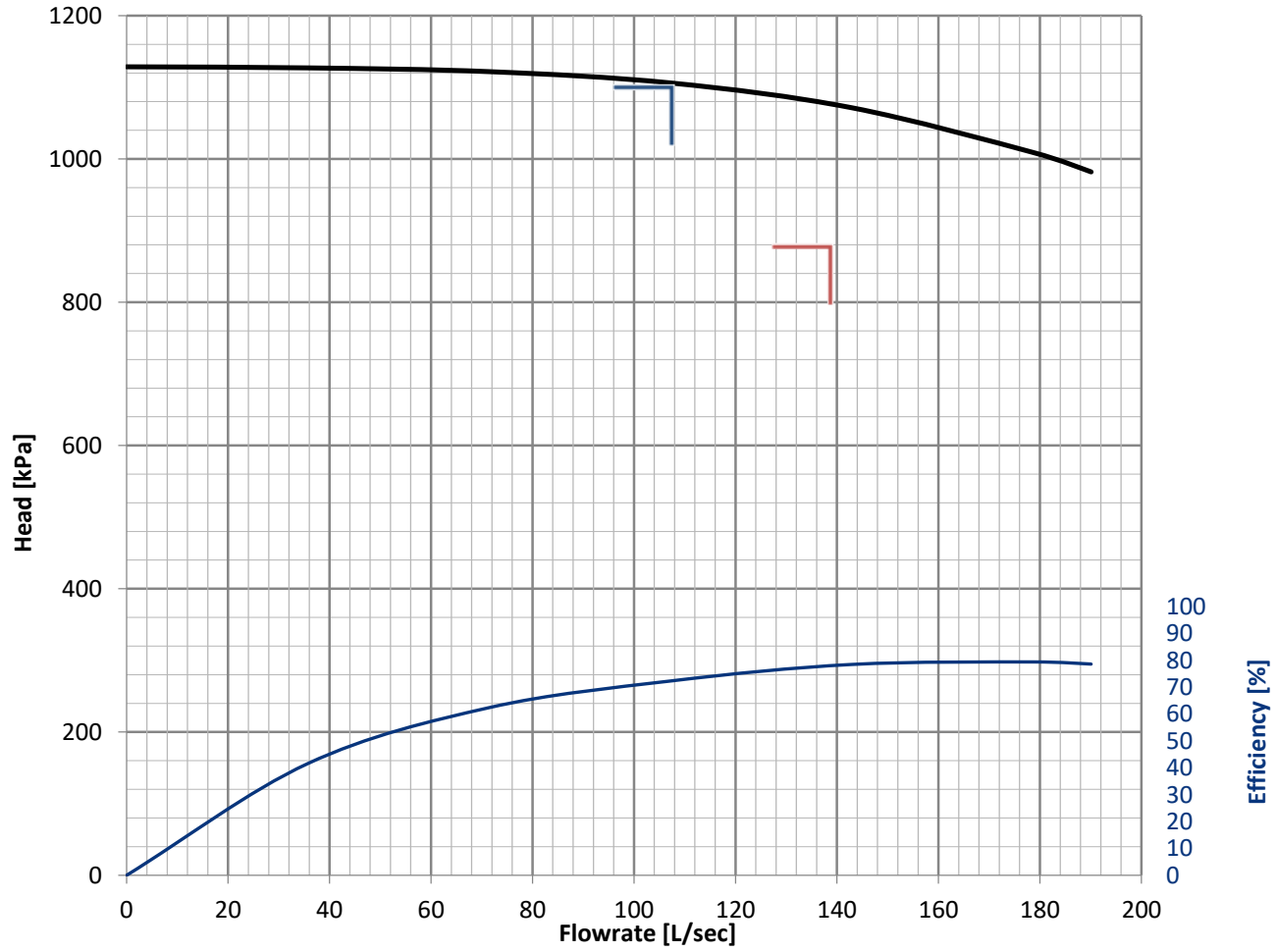


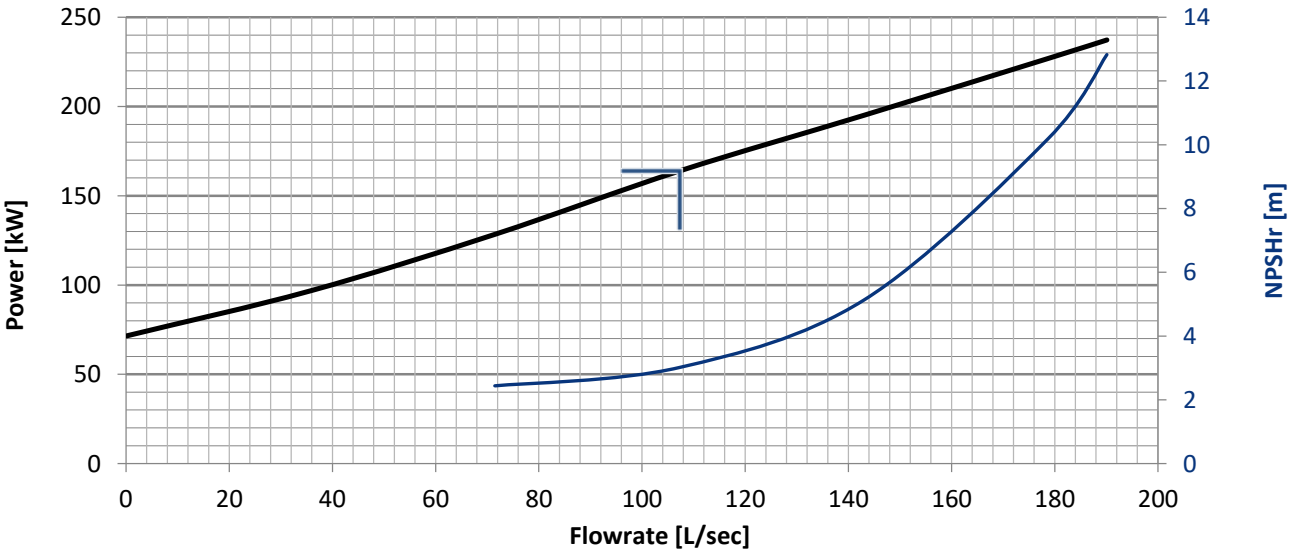
Performance to ISO9906 Grade 2 for clean cold water only

CORDE pumps

EH200x150-500

ISO2858 END SUCTION PUMP
PERFORMANCE CURVE
EH SERIES
IMPELLER DIAMETER: 456mm





Duty Flow (L/sec):	107	Duty Power (kW):	164	Speed (RPM):	1800
Duty Head (kPa):	1100	Qmax Power (kW):	192	Impeller Ø (mm):	456
Qmax Flow (L/sec):	139	Power Margin (%):	15		
Qmax Head (kPa):	880	Power Req. (kW):	220		

ISO9906-2012 Grade 2B Performance: Clean Water
AS2941-2013 Driver Power Requirements

Powered By PUMP-FLO

Jockey Pump:

Size:	AV10-10
Type:	AV
Synch Speed:	Adjustable
Dia:	92.4 mm
Curve:	---
Impeller:	92.4

Search Criteria:

Flow:	9.6 m³/hr	Near Miss:	---
Head:	800 kPa	Static Head:	0 kPa

Pump Selection Warnings:

None

Fluid:

Name:	Water		
SG:	1	Vapor Pressure:	1.77 kPa a
Density:	999 kg/m³	Atm Pressure:	101 kPa a
Viscosity:	1.1 cP		
Temperature:	15.6 °C	Margin Ratio:	1

Pump Limits:

Temperature:	---	Sphere Size:	---
Wkg Pressure:	---		

Motor:

Consult manufacturer to select a motor for this pump.

--- Duty Point ---

Flow:	9.6 m³/hr
Head:	800 kPa
Eff:	66.8%
Power:	3.18 kW
NPSHr:	2.15 m
Speed:	2888 rpm

--- Design Curve ---

Shutoff Head:	983 kPa
Shutoff dP:	983 kPa
Min Flow:	--- m³/hr

BEP: 67% @ 9.99 m³/hr

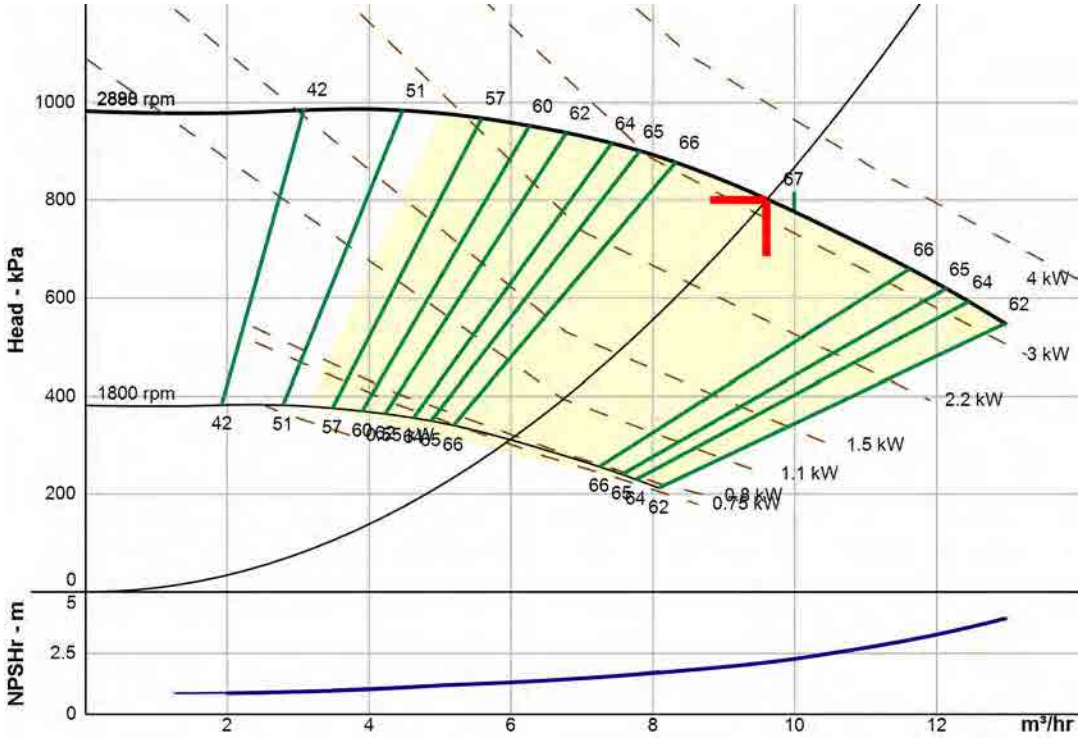
NOL Power:

3.24 kW @ 10.5 m³/hr

--- Max Curve ---

Max Power:

3.25 kW @ 10.5 m³/hr



Performance Evaluation:

Flow	Speed	Head	Efficiency	Power	NPSHr
m³/hr	rpm	kPa	%	kW	m
11.5	2888	669	66.1	3.23	2.98
9.6	2888	800	66.8	3.18	2.15
7.68	2888	906	64.7	2.99	1.61
5.76	2888	964	57.8	2.67	1.28
3.84	2888	986	47.1	2.23	1.01

Port Kembla Gas Terminal

FIRE WATER HYDRAULIC CALCULATIONS

PKGT-LOG-ORF-SAF-CAL-0001

Current Revision

Revision:	Reason for Revision:	Revision Date:	
0	Issued for Use	06/09/2022	
Prepared By:	M. Zarrin Mehr	Date: Signature:	06/09/2022
Reviewed By:	Dave Afshari	Date: Signature:	06/09/2022
Approved By:	Craig Sheather	Date: Signature:	06/09/2022

Synopsis

This document outlines the water demands and hydraulic analysis of the fire water system for the Onshore Receiving Facility (ORF) at Port Kembla Gas Terminal.

Disclaimer

Revision History

Rev	Revision Date	Reason for Revision	Prepared By	Reviewed By	Approved By
A	14/02/2022	Issued for Review	M. Zarrin Mehr	Dave Afshari	Craig Sheather
B	31/07/2022	Issued for Review	M. Zarrin Mehr	Dave Afshari	Craig Sheather
0	08/09/2022	Issued for Use	M. Zarrin Mehr	Dave Afshari	Craig Sheather

REVISION PAGE

REV	SECTION	DESCRIPTION
B	All Sections	Client comments incorporated.
B	5,6 and Appendices	Updated according to the latest 3D model and PMS
0	Executive Summary	In the second line, reference No. is deleted.
HOLDS	**SECTION**	**DESCRIPTION**

CONTENTS

1 EXECUTIVE SUMMARY

This Fire Water Calculation report has been prepared for the Port Kembla Gas Terminal (PKGT) Project per the requirements of the Australian Standards and Regulations and in line with the methodology outlined in Worley's Fire Safety Study Report [1]. Estimating the maximum fire water demand is determined based on the required fire water for the Onshore Receiving Facility (ORF) only, not the Floating Storage Regasification Unit (FSRU). The FSRU will be provided adequate onboard fire protection resources to mitigate the risk of escalation of a fire event onboard without the need for additional shore-based protection, with reference to Worley's Fire Protection Philosophy [2]. An International Ship to Shore Connection is available, However, because size and capacity are very small compared to other consumers and will be used in some particular situations, it has been excluded from the hydraulic calculation.

The maximum required water, 12,842 L/min (~770m^3/hr), to provide exposure protection to the ORF equipment has been considered for the sizing of the firewater pumps, fire water tanks, and the ring main.

The Key Findings of this calculation establish that:

- The fire water ring main has been sized to be 400HDPE PN16 SDR11 for underground and DN350 for above-ground steel piping.
- The firewater pump (100% duty) should have a duty point of 770 m^3 /hr at 1100 kPa.

2 INTRODUCTION

Australian Industrial Energy (AIE) has the objective to provide a new source of competitively priced gas to New South Wales (NSW) industrial and wholesale customers. AIE is planning to supply up to 100PJ per annum, corresponding to approximately 75% of NSW gas demand from early 2020. As a new entrant to the Australian east coast energy market, AIE will create a virtual pipeline enabling delivery of gas from low-cost destinations and therefore support the National Electricity Market security and reliability. AIE will source competitively priced Liquefied Natural Gas (LNG) and will be selling gas to industrial and wholesale customers on stable prices and terms.

The LNG Terminal will involve a Floating Storage and Regasification Unit (FSRU) permanently moored at Berth 101 on the East side of Port Kembla. LNG carriers will moor in a side-by-side configuration to offload the LNG to the FSRU where it will be re-gasified and transported to shore via an onshore pipeline for tie-in the existing Eastern Gas Pipeline (EGP) network.

This report outlines the firewater demand and hydraulic requirements for the firewater system of the Onshore Receiving Facility (ORF) only. It shall be read in conjunction with the respective detailed engineering documentation of the firefighting system.

2.1 Hydraulic Calculation Purpose

The purpose of the hydraulic calculation is to ensure that the fire system is hydraulically optimised. It will provide requirements for pump discharge pressure(s) and fire system pipe sizes, depending on the required flow and pressure at the most remote fire monitors.

2.2 Exclusions

- Fire Safety Study has been prepared by Worley. [1]
- Fire water design basis
- FSRU fire water system
- Ship to shore fire water

2.3 Definition of Terms

2.3.1 Project Stakeholders

The relevant stakeholders identified for this project are listed in the table below.

Table-1: Project Stakeholders

Company/Person	Role
Australian Industrial Energy (AIE)	Client
LogiCamms Pty Ltd	AIE Consultant for Detailed Design
SafeWork NSW	Fire and Safety Authority
Fire and Rescue NSW	Fire and Safety Authority
Fire Engineering Solution (QLD) Pty Ltd (FESQ)	LogiCamms Consultant for Fire Protection Detail Design
Worley Parsons Pty Ltd	AIE Safety Consultant

2.3.2 Abbreviations

The abbreviations utilised in this project are listed below:

Table 2: Abbreviation

Terminology	Definition
AIE	Australian Industrial Energy
CCTV	Closed Circuit Television
FEED	Front End Engineering Design
FRNSW	Fire and Rescue NSW
FSRU	Floating Storage Regasification Unit
ISGOTT	International Safety Guide for Oil Tankers and Terminals
LNG	Liquefied Natural Gas
MLA	Marine Loading Arm
NSW	New South Wales
ORF	Onshore Receiving Facility
PKGT	Port Kembla Gas Terminal
kPa	kilopascal, The pressure difference between the fire water and atmospheric pressure

3 APPLICABLE DOCUMENTS

3.1 Project Documentations

The following table lists the Company and Project Documents:

Table 3: Applicable Project Documents

Ref. No.	Reference	Title
1.	PKGT-WOR-ORF-SAF-STY-0001	Fire Safety Study Report
2.	PKGT-ADV-PMT-SAF-PHL-0001	Fire Protection Philosophy
3.	PKGT-LOG-ORF-PRO-PAIA-0009	Fire water Pumps and Storage Tanks P&ID
4.	PKGT-LOG-ORF-PRO-PAIA-0010	Fire water Main Ring, Fire Monitors and Hydrants P&ID
5.	PKGT-LOG-ORF-PEQ-MOD-0001	3D Navisworks Model on 22/07/2022
6.	PKGT-LOG-ORF-PIP-SPC-0001	Piping Martial Specification- Class 1PD0A02 & CS12S01

3.2 Codes and Standards

The table below lists the Standards that are applicable:

Table 4: Applicable Standards

Ref. No.	Reference	Title
1.	AS 1940	Flammable Liquids Storage and Handling
2.	AS 2304	Water Storage Tanks for Fire Protection Systems
3.	AS 2419.1	Fire Hydrant Installations
4.	AS 2941	Fixed Fire Protection Installations – Pumpset Systems
5.	AS 3846	The handling and transportation of dangerous cargoes in port areas
6.	ISGOTT	ISGOTT International Safety Guide for Oil Tankers and Terminals

4 FIREWATER DEMANDS

The maximum required water flowrate to provide fire protection to the ORF areas and equipment has been considered in this Section.

The ORF can be divided into the following demands to determine the maximum fire water hydraulic scenarios.

4.1 Ship/Shore Manifold Area

Referring to Fire Protection Philosophy [2], the ship/shore manifold area should be provided with fire monitors with a flow rate based on an application rate of 4 L/min/m^2 with an additional 15% windage contingency factor equating to 12,812 L/min (6,406 L/min each monitor).

4.2 Open Yard Areas

As required by Fire Protection Philosophy [2], the fire hydrants will be arranged to provide coverage of the open yard areas. PKGT has the following open yard areas for hydrant fire protection:

- Process area including MLA area, odorant area, pig launcher area. The process area in total is less than 2000 m2 in area.
- Non-process area including fire water pump house and tank, parking and utilities area. The non-process area in total is less than 1500 m2 in area.

Referring to AS 2419, Table 2.2.2 (E), both open yards are less than 3000 m2 in area. As a result, 600 L/min fire water from the hydrant system is sufficient.

5 HYDRAULIC DESIGN BASIS

Methodology:

The hydraulic calculations have been carried out using the ACADS software package HYENA+, approved for fire protection hydraulic calculations in Australia.

The calculation is developed based on the Hazen Williams equation to calculate the pressure drop and equivalent lengths for reducers, enlargers, entries, exits and where a user-defined k-value was used.

Scenarios:

1. Two fire monitors in operation- Full ring main in service.
2. Two fire monitors in operation- Half ring main in service as required by Fire Protection Philosophy [2].
3. Fire brigade boosting condition- The most hydraulically disadvantaged double hydrant in operation

Design velocity

The water velocity in pipework shall not exceed four (4) m/s.

Hydraulic loss—Pipes, valves and fittings

The total hydraulic loss due to friction in pipes, valves and fittings between the booster inlet connection of the fire brigade booster assembly and the outlet of the most hydraulically disadvantaged fire hydrant shall not exceed 150 kPa according to AS2419.

Deluge valve pressure loss= 15 kPa

Inputs:

Minimum Fire water Flowrate= 12,812 L/min (770m³/hr) Equal to two fire monitor capacities

Discharge pressures

- Minimum required pressure at Monitor nozzle inlets= 700 kPa (This pressure is the minimum to achieve 70m coverage distance from the monitor discharge nozzle)
- Minimum required pressure at hydrant inlets according to AS2419.1 = 700 kPa

Monitor K- Factors: 242 L/min (KPa)^0.5 (Calculated based on a pressure of 700 kPa and 6406 L/min flowrates)

The minimum design pressure of the discharge pipework and components of the pump installation shall be based on the maximum pump suction pressure plus the pump churn pressure. Since the maximum allowable working pressure for the HDPE piping is 1600 kPa, the pressure in any section of the fire water system shall not exceed that value. Thus, the pump churn pressure plus the maximum pump suction pressure shall not exceed 1600 kPa. In the absence of the flow and pressure characteristics of the pumping units, pump churn pressure is conservatively considered 140% of the duty pressure given that an AS2941 pump shall not exceed 140% of its duty head at the shut-off point or any other point along its characteristic curve. As a result, the discharge pressure of the pump at the duty head point cannot exceed 1,100 kPa.

Pipe Material:

- Underground: HDPE- Hazen Williams Coefficient of 140. according to the Fire Protection Philosophy [2]
- Aboveground: Carbon Steel Galvanized- Hazen Williams Coefficient of 120.

Pipe sizes:

- HDPE according to the pipe material class of 1PD0A02
- Carbon Steel according to pipe material class of 1C12S02

Pipe length= Measured from the node diagram extracted from the 3D Navis model (Appendix A)

Pipe fittings: Based on the 3D Navis model (Appendix A)

Elevation change: Based on the 3D Navis model (Appendix A)

Safety Factor: 0%

6 HYDRAULIC ANALYSIS

The optimised pipe sizes and required pump discharge pressure is determined by hydraulic calculations.

Appendix C and Appendix D show the software outputs. In Appendix C, the entire ring is in service, but in Appendix D, half of the ring is supposed to be out of service due to maintenance.

The worst-case hydraulic scenario is the activation of fire monitors FM-101 and FM-102 when half of the ring is out of service.

The monitors will not have equal discharge flow rates as they have the same K- factors with different monitor inlet pressures.

In Appendix E, the total hydraulic loss between the booster inlet connection and the outlet of the most hydraulically disadvantaged fire hydrants is checked and is less than 150 kPa.

The results of the hydraulic calculations for the scenarios indicated above are summarised in Table 6.

In addition, the minimum required ring main size is 14" or HDPE 400mm, which enables the pumps to deliver the required pressure of 700 kPa to the monitors.

Table 6: Summary of Hydraulic Results

Scenario No.	Description		Required Pump Discharge Flow and Pressure
1	Ship/Shore Manifold Area on Fire. Therefore FM-101 and FM-102 will be activated	The whole main ring is in service	12,842 L/min at 1000 kPa
2		Half of the main ring is in service	12,832 L/min at 1081 kPa
3	Hydrants FH-101, 102 and 103 are open	The whole main ring is in service	600 L/min at 701 kPa

6.1 Conclusion

According to Table 7, the design case for the ORF's fire water system will be the ship/shore manifold area protection when half of the ring main is in service. The maximum fire water demand equates to ~ 12,839 LPM (~770m^3/hr).

The Key Findings of this calculation establish that:

- The firewater ring main has been sized 14" or HDPE 400mm.
- The firewater pump (100% duty) should have a duty point of 770 m^3 /hr at 1100 kPa.

Table 7: Fire Water Demand

Item	Protected Area	Total Demand
1	Ship/Shore Manifold Area	12,812 L/min
2	Open Yard Area	600 L/min
	Theoretical Maximum Fire Water Demand (include 15% contingency factor for windage)	12,812 L/min (~770 m^3/hr)
	Calculated Fire Water Demand based on hydraulic modelling (including 15% contingency factor for windage)	12,842 L/min (~770 m^3/hr)

APPENDICES

APPENDIX A- NODE DIAGRAM

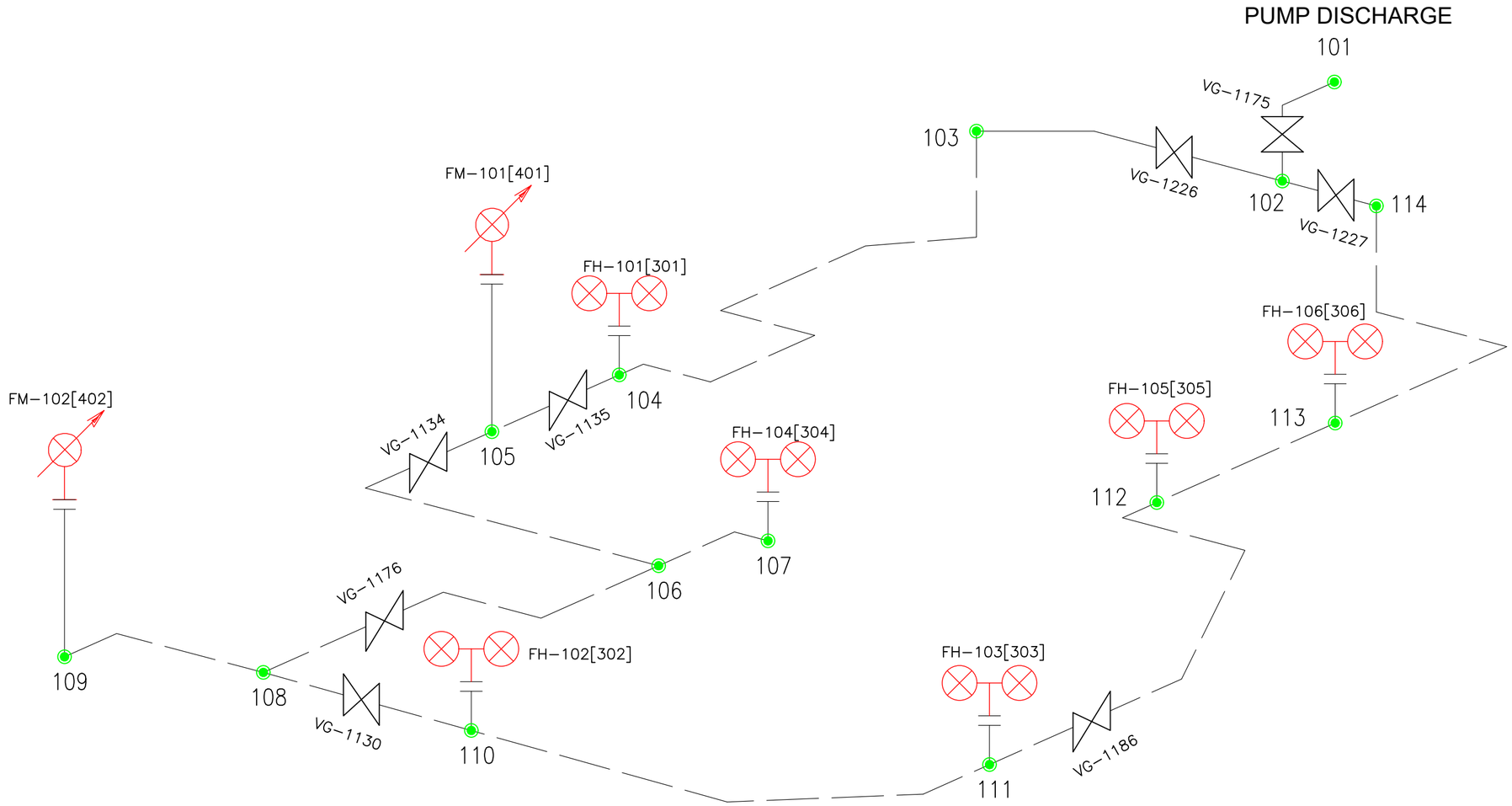
APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

APPENDIX C – HYDRAULIC CALCULATION- FULL RING

APPENDIX D – HYDRAULIC CALCULATION- HALF RING

APPENDIX E – HYDRAULIC CALCULATION- PRESSURE LOSS FOR BOOSTING CONDITION

APPENDIX A-NODE DIAGRAM



LEGEND:

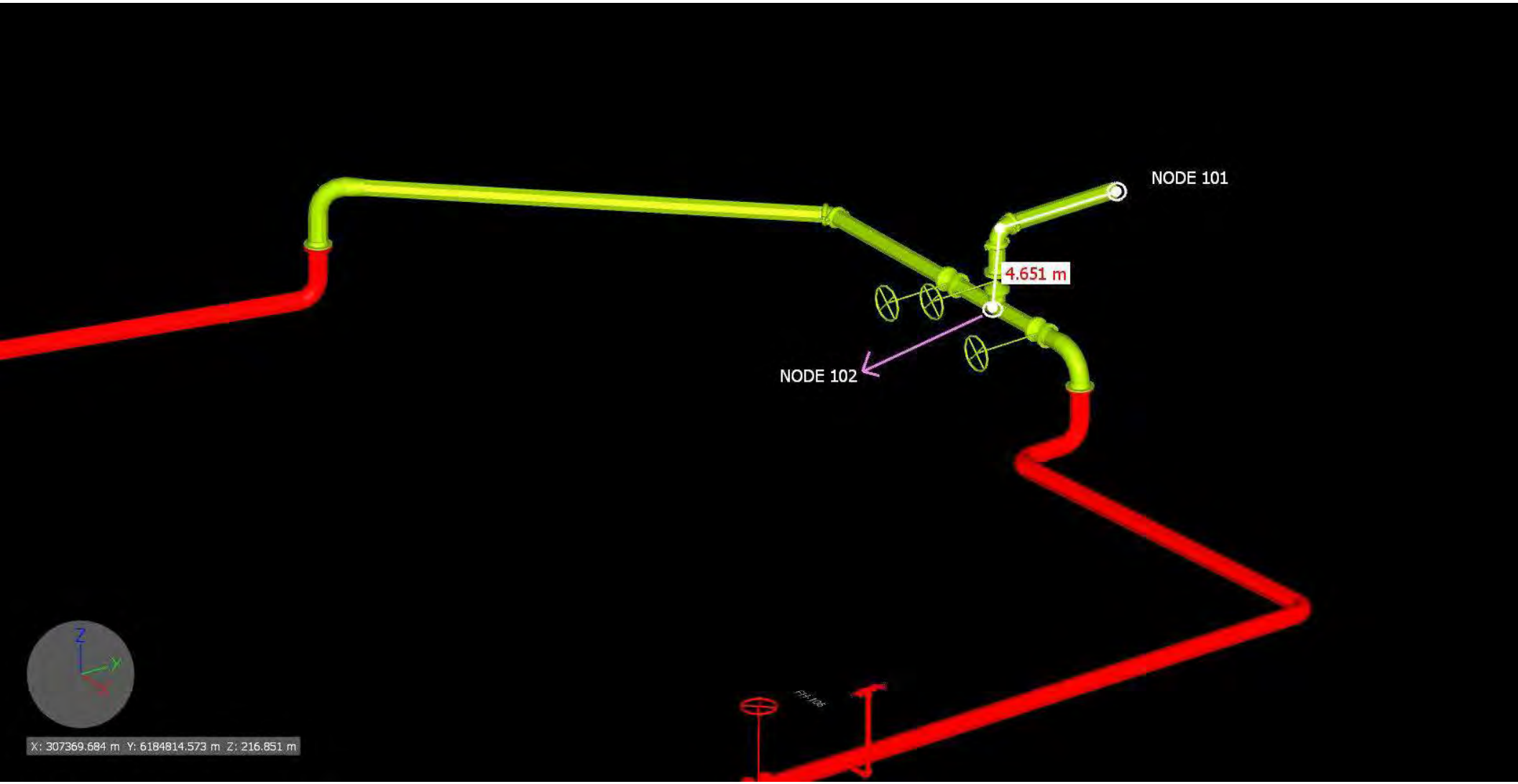
- UNDERGROUND
- ABOVE GROUND
- NODE
- HYDRANT
- FIRE MONITOR
- GATE VALVE

REFERENCES:

1. NAVISWORKS-PKGT-LOG-ORF-PEQ-MOD-0001
   RECEIVED ON: (20/07/2022).
2. WHARF TOPSIDE FIREWATER PUMPS AND STORAGE TANKS
   PIPING AND INSTRUMENTATION DIAGRAM
   PKGT-LOG-ORF-PRO-PAIA-0009-REV C.
3. WHARF TOPSIDE FIREWATER MAIN RING , FIRE MONITORS
   AND HYDRANTS PIPING AND INSTRUMENTATION DIAGRAM
   PKGT-LOG-ORF-PRO-PAIA-0010-REV C.

PIPE LENGTH TABLE			
NODE NOS.	LENGTH (m)	SIZE	MATERIAL
101-102	4.7	14 in	CARBON STEEL
102-103	16.9	14 in	CARBON STEEL
102-114	3.6	14 in	CARBON STEEL
103-104	187.2	400 mm	HDPE
104-301	2.8	4 in	CARBON STEEL
104-105	36.6	400 mm	HDPE
105-401	28.5	8 in	CARBON STEEL
105-106	43.2	400 mm	HDPE
106-107	11.2	125 mm	HDPE
107-304	2.1	4 in	CARBON STEEL
106-108	58.2	400 mm	HDPE
108-109	13.4	250 mm	HDPE
109-402	23.9	8 in	CARBON STEEL
108-110	6	400 mm	HDPE
110-302	2.9	4 in	CARBON STEEL
110-111	60.3	400 mm	HDPE
111-303	2.5	4 in	CARBON STEEL
111-112	193	400 mm	HDPE
112-305	2.7	4 in	CARBON STEEL
112-113	53.7	400 mm	HDPE
113-306	2.6	4 in	CARBON STEEL
113-114	24.2	400 mm	HDPE

NODE 101 TO 102



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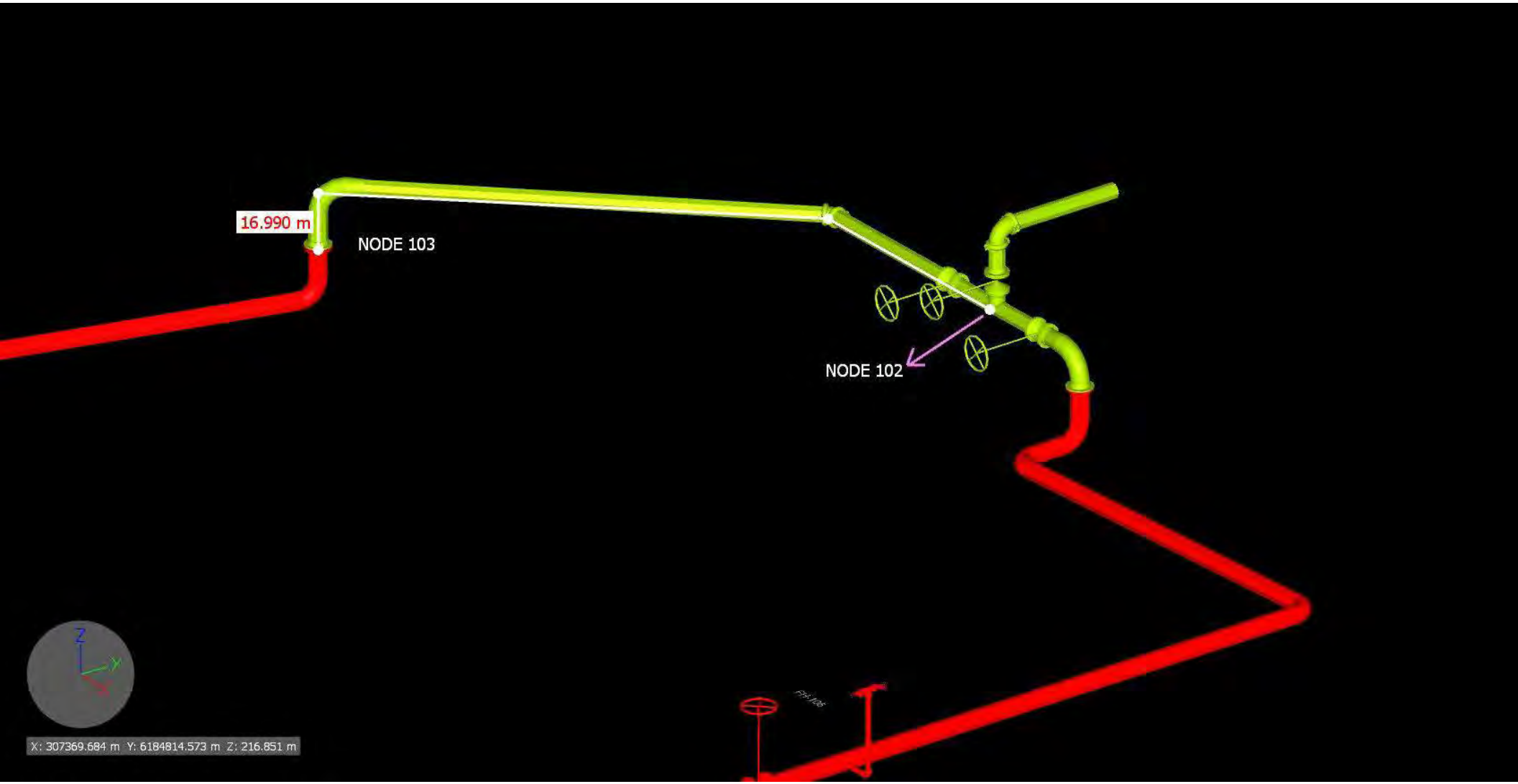
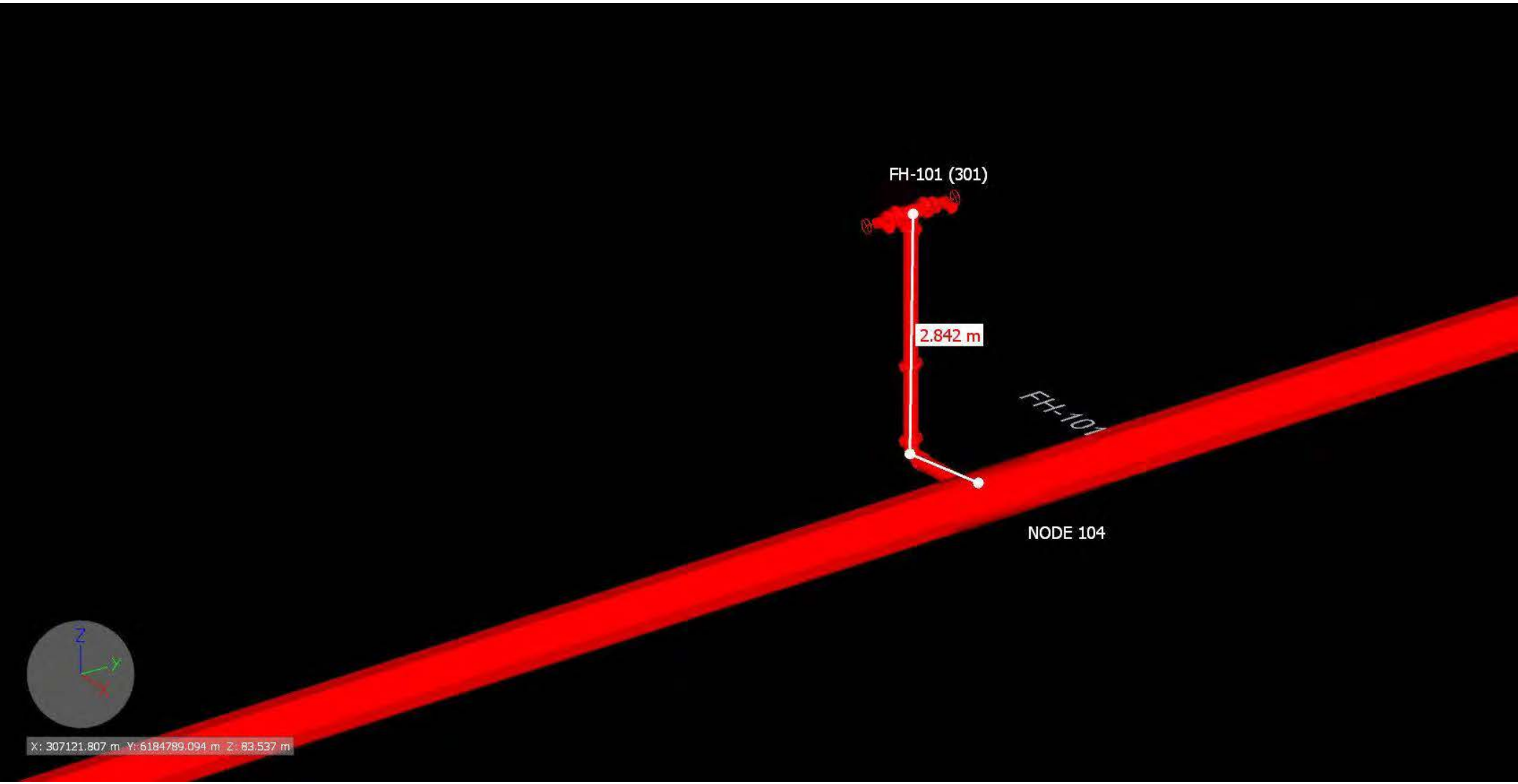


NODE 103 TO 104

NODE 104 TO 301



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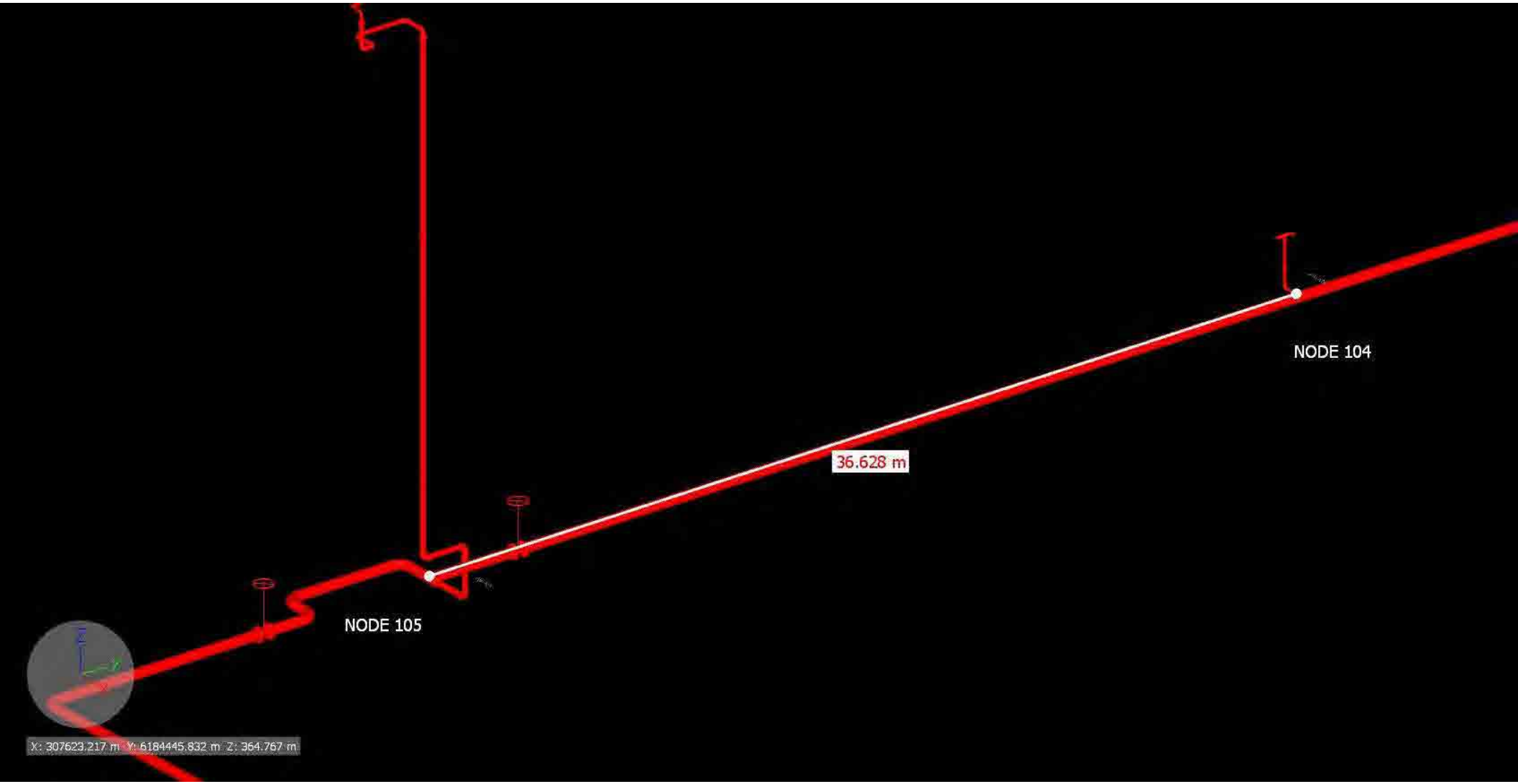

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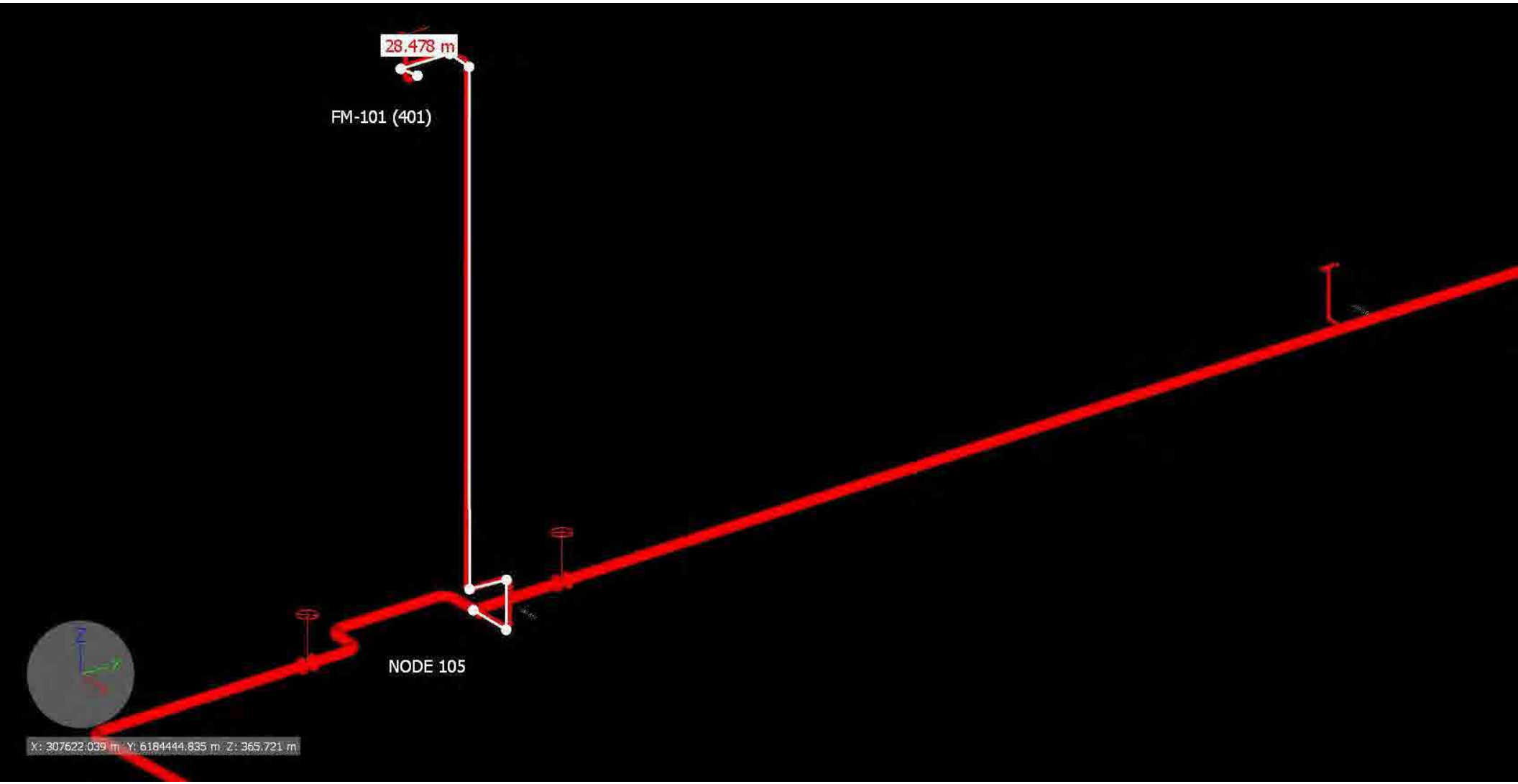

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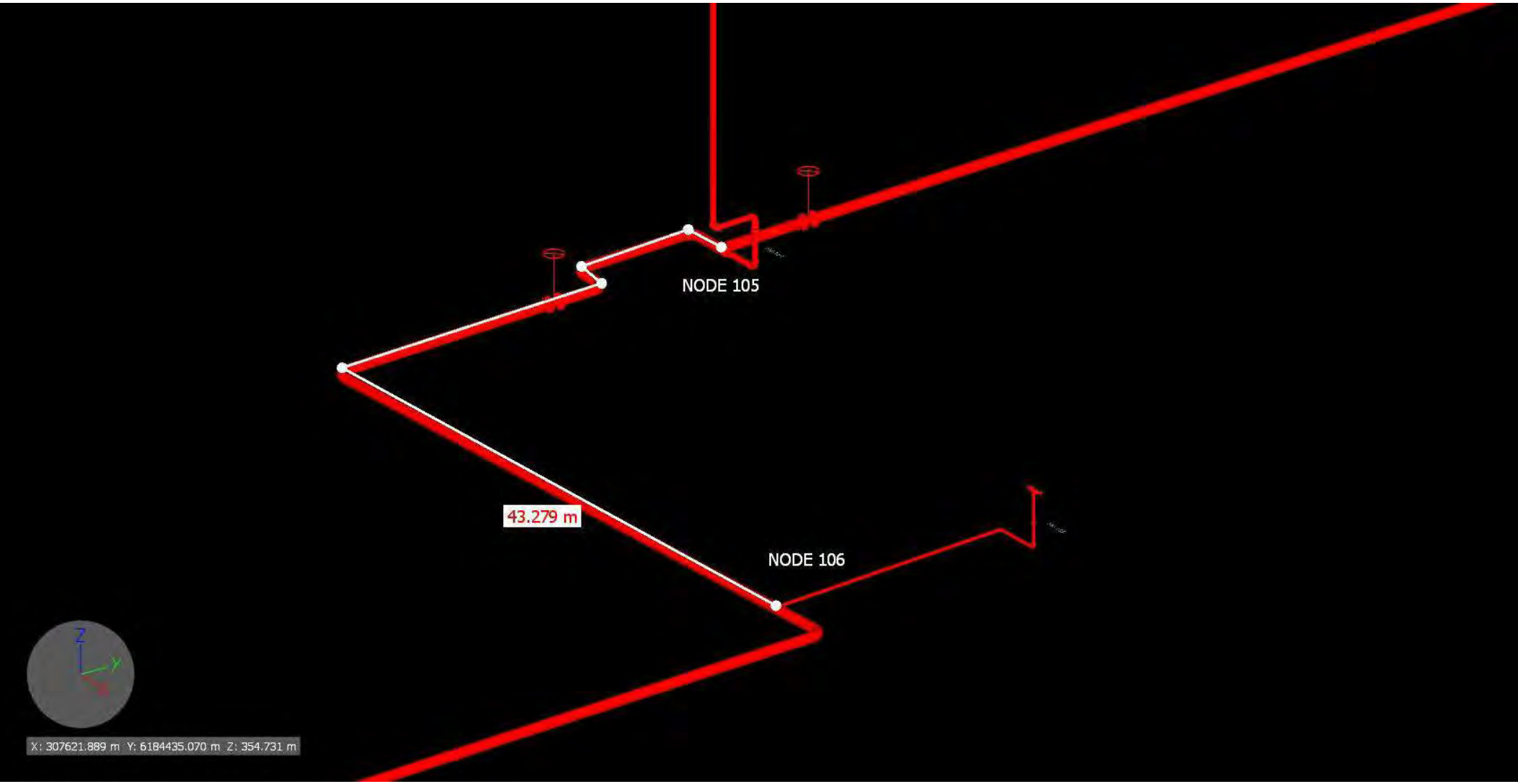

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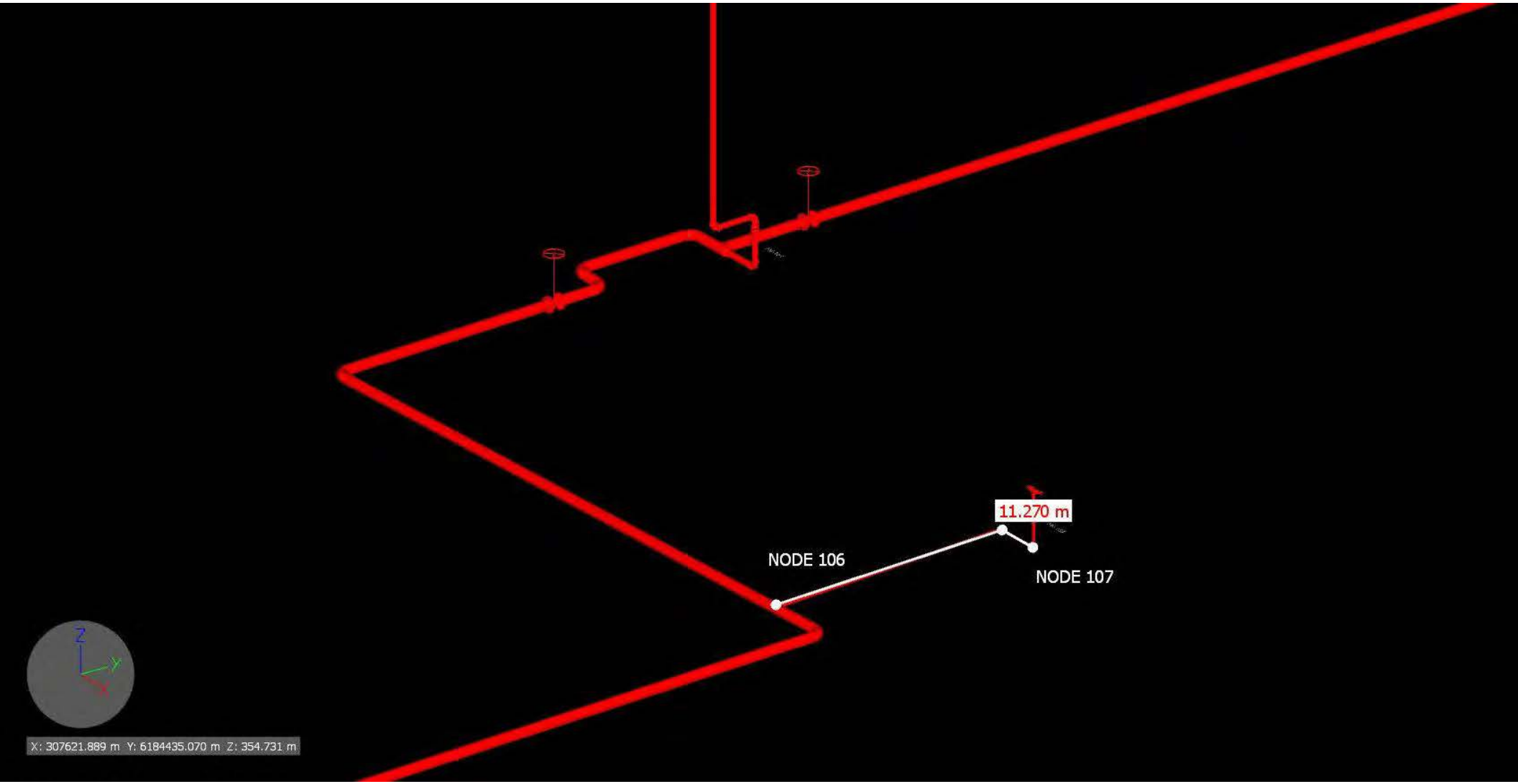

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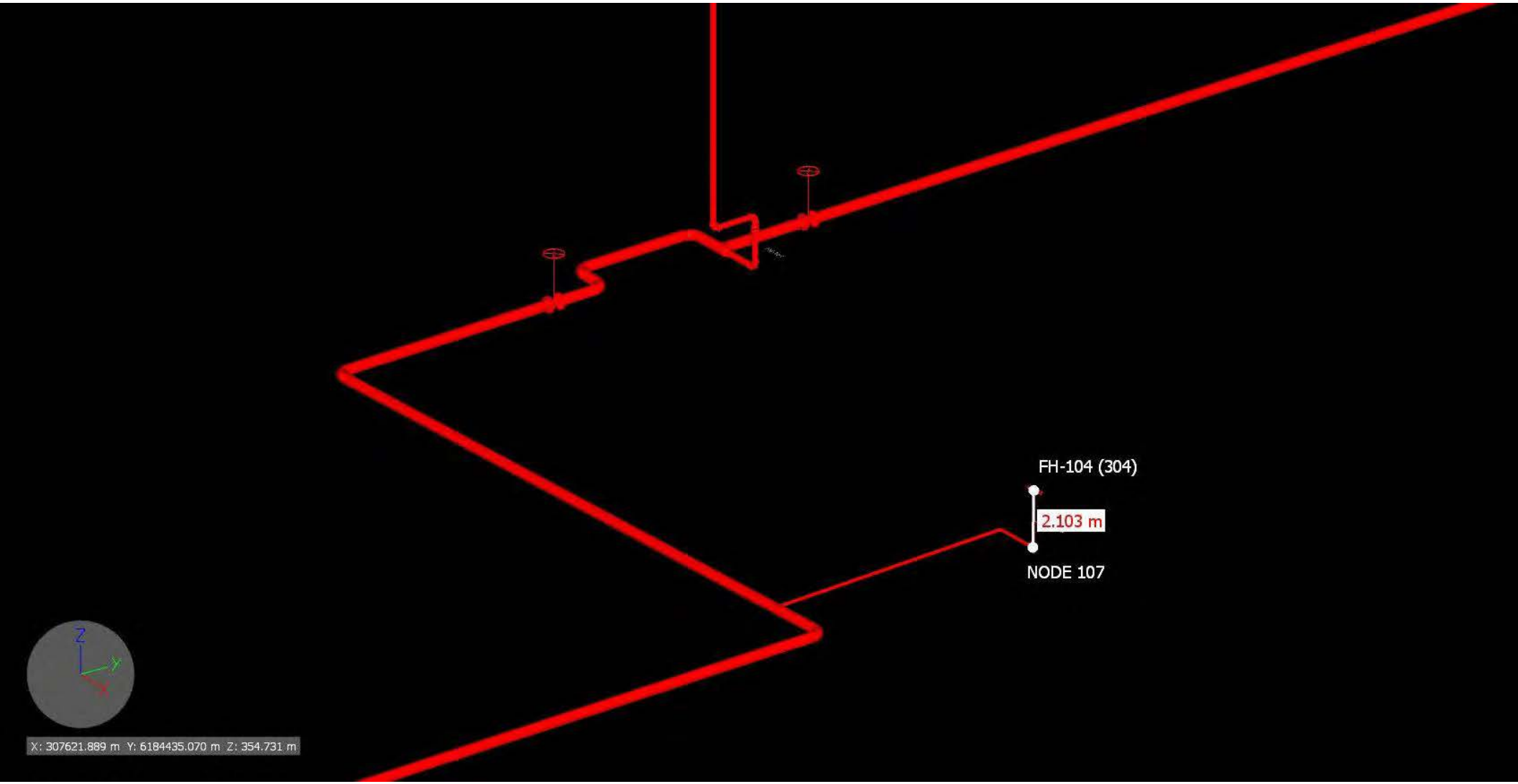

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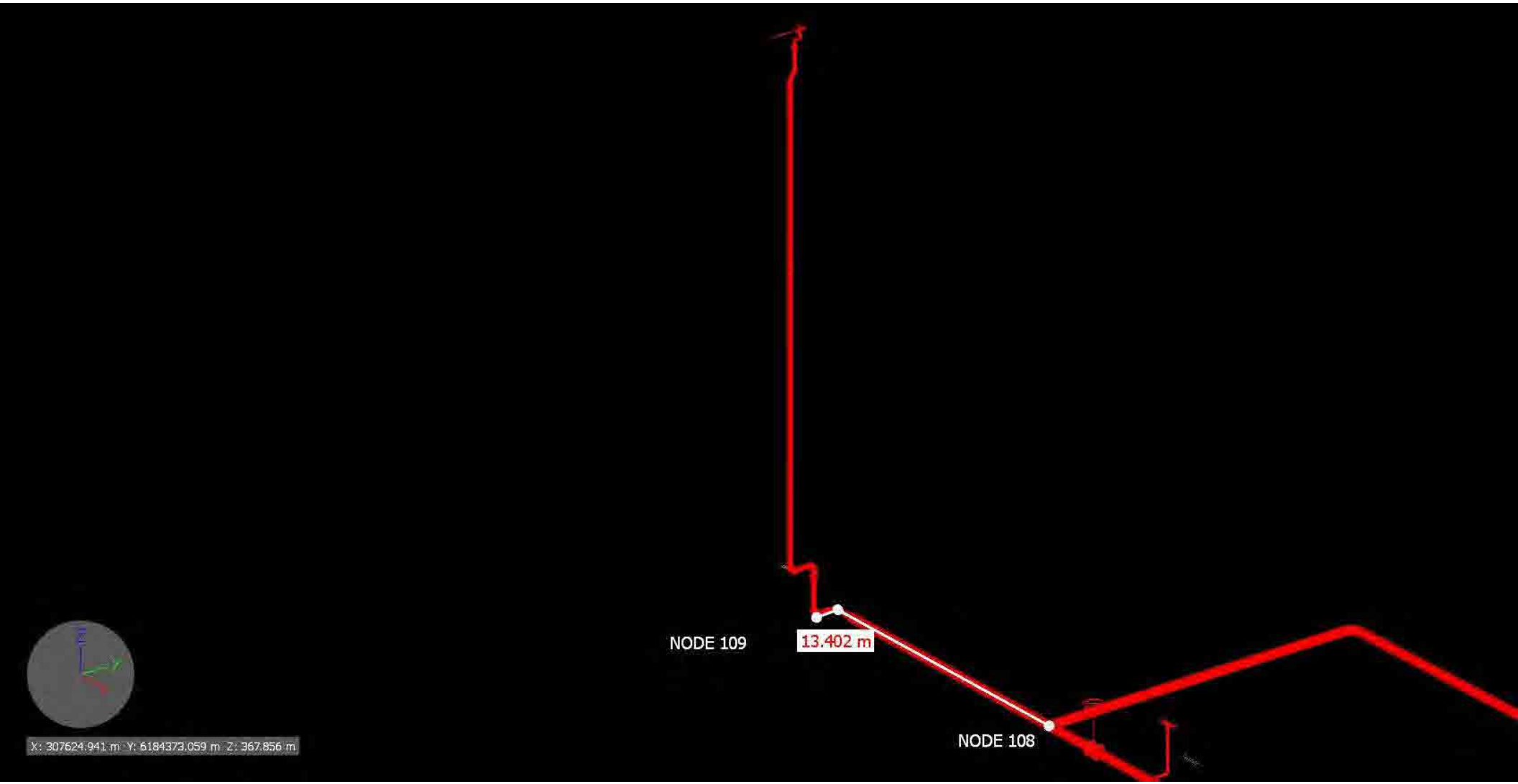

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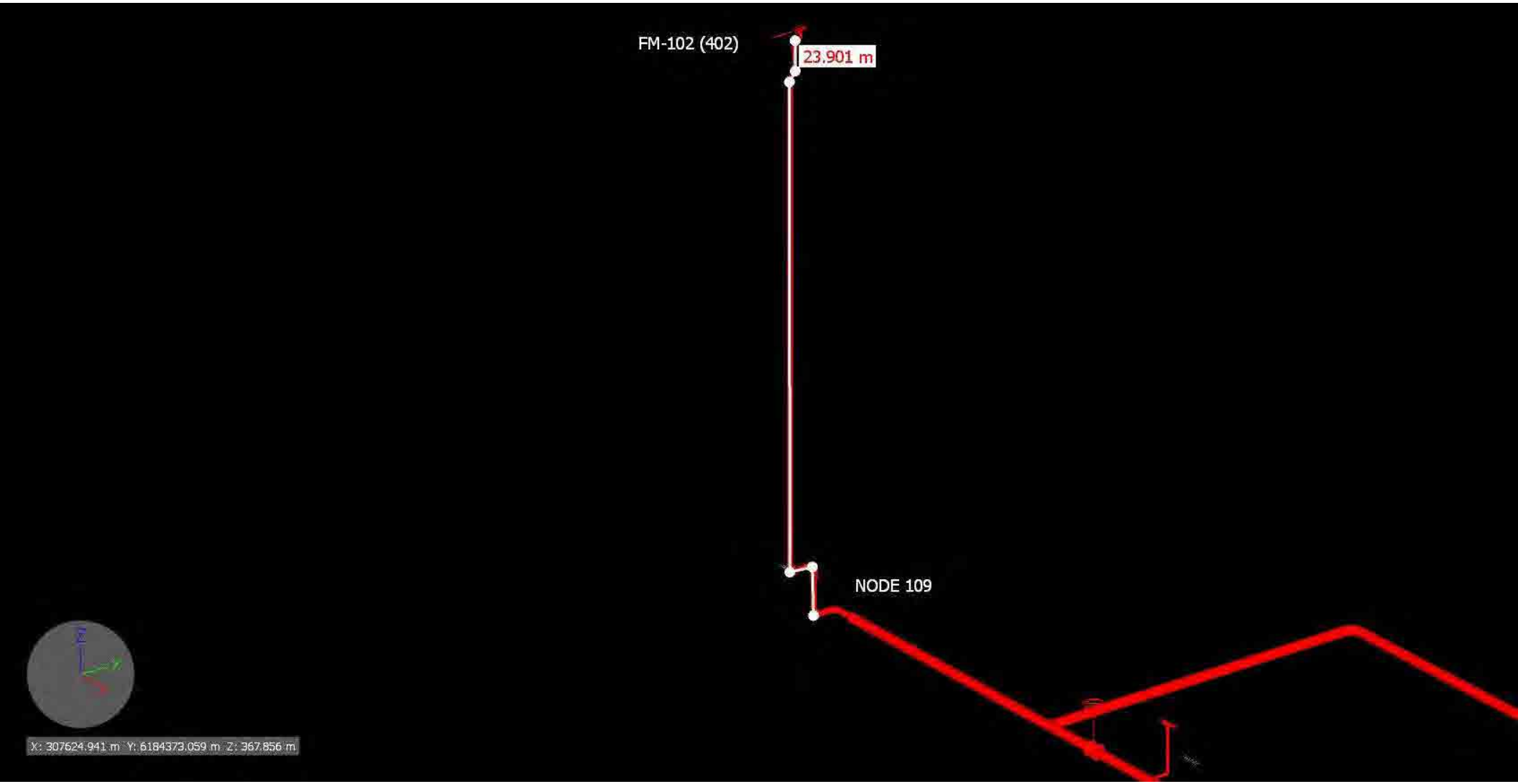

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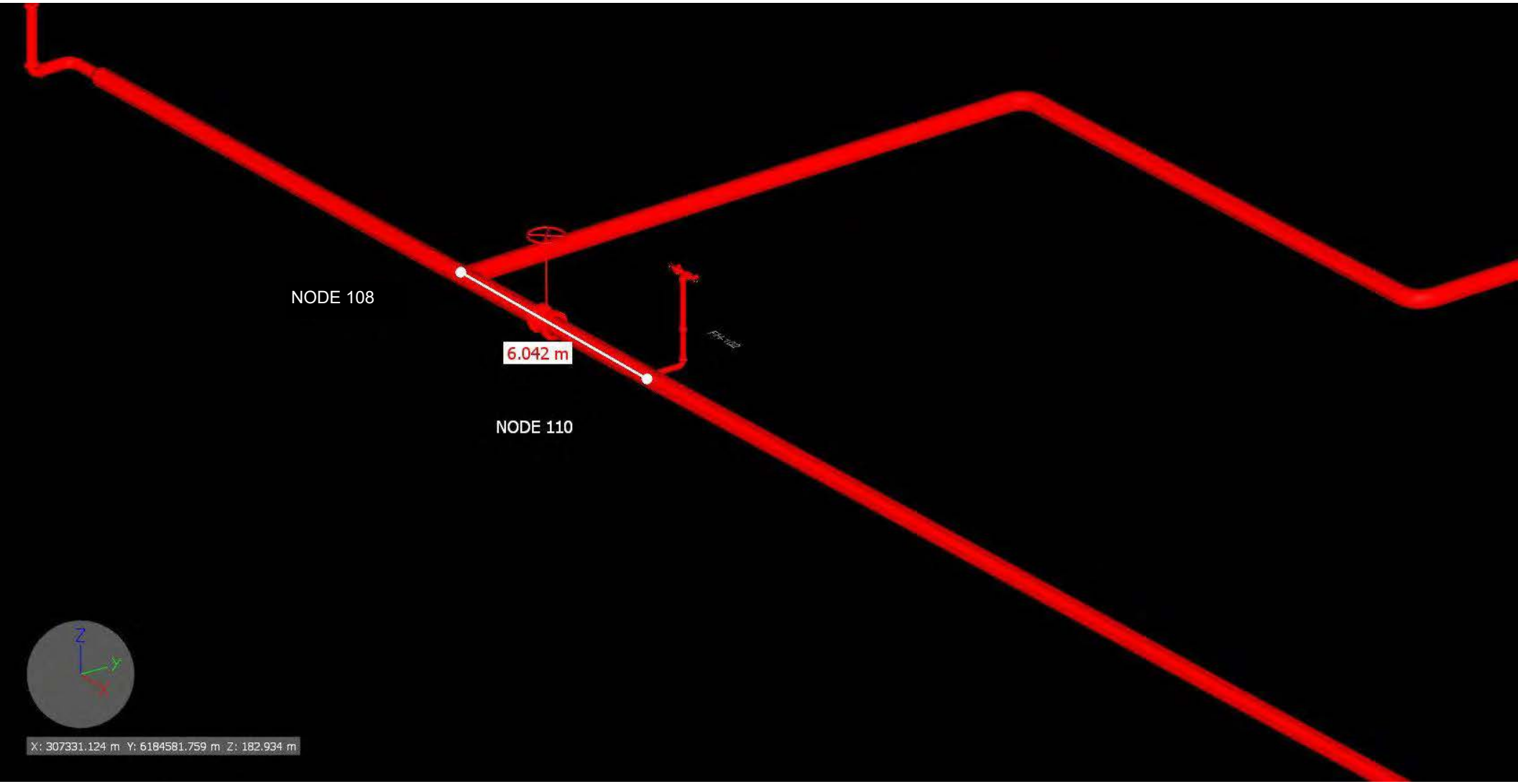

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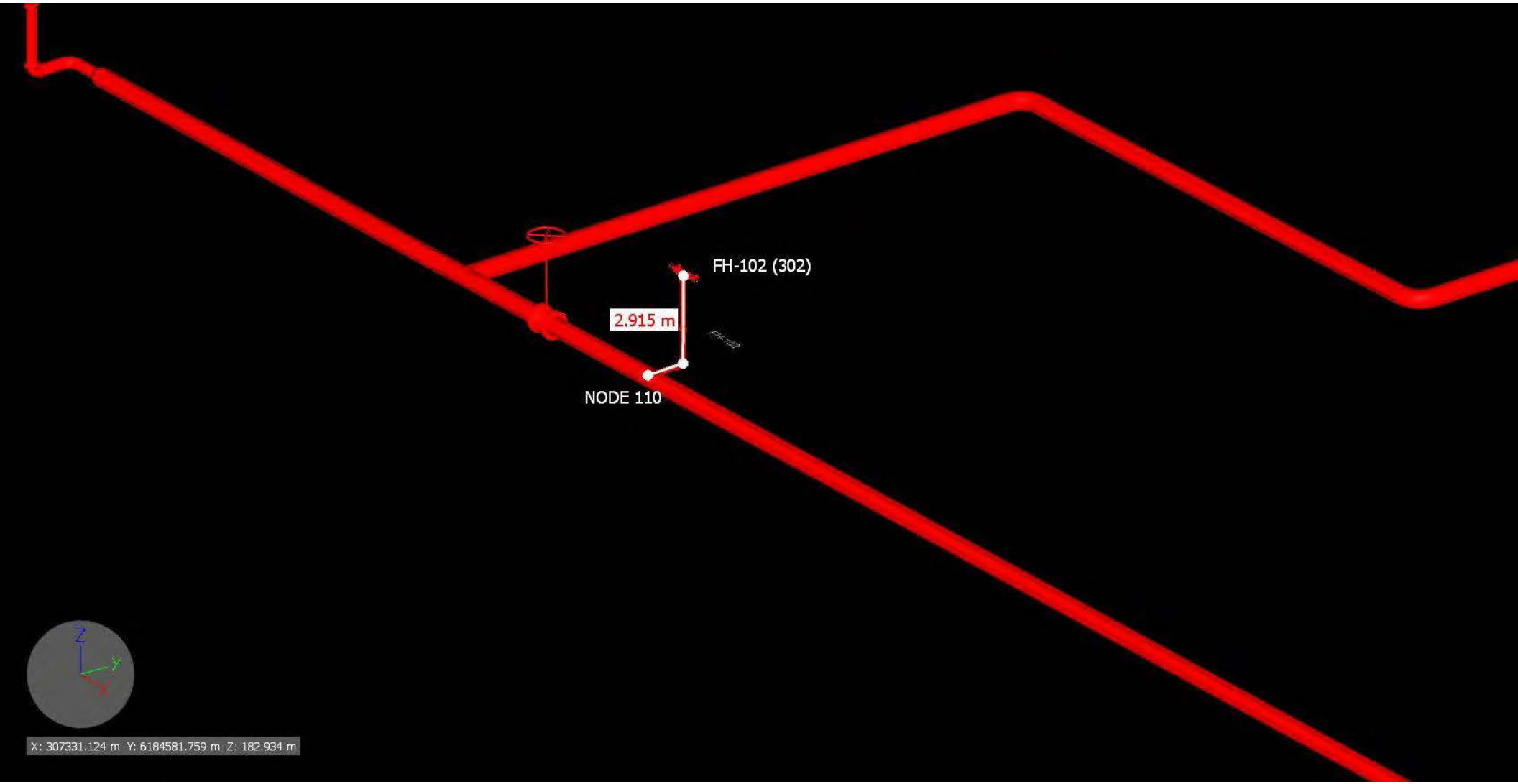

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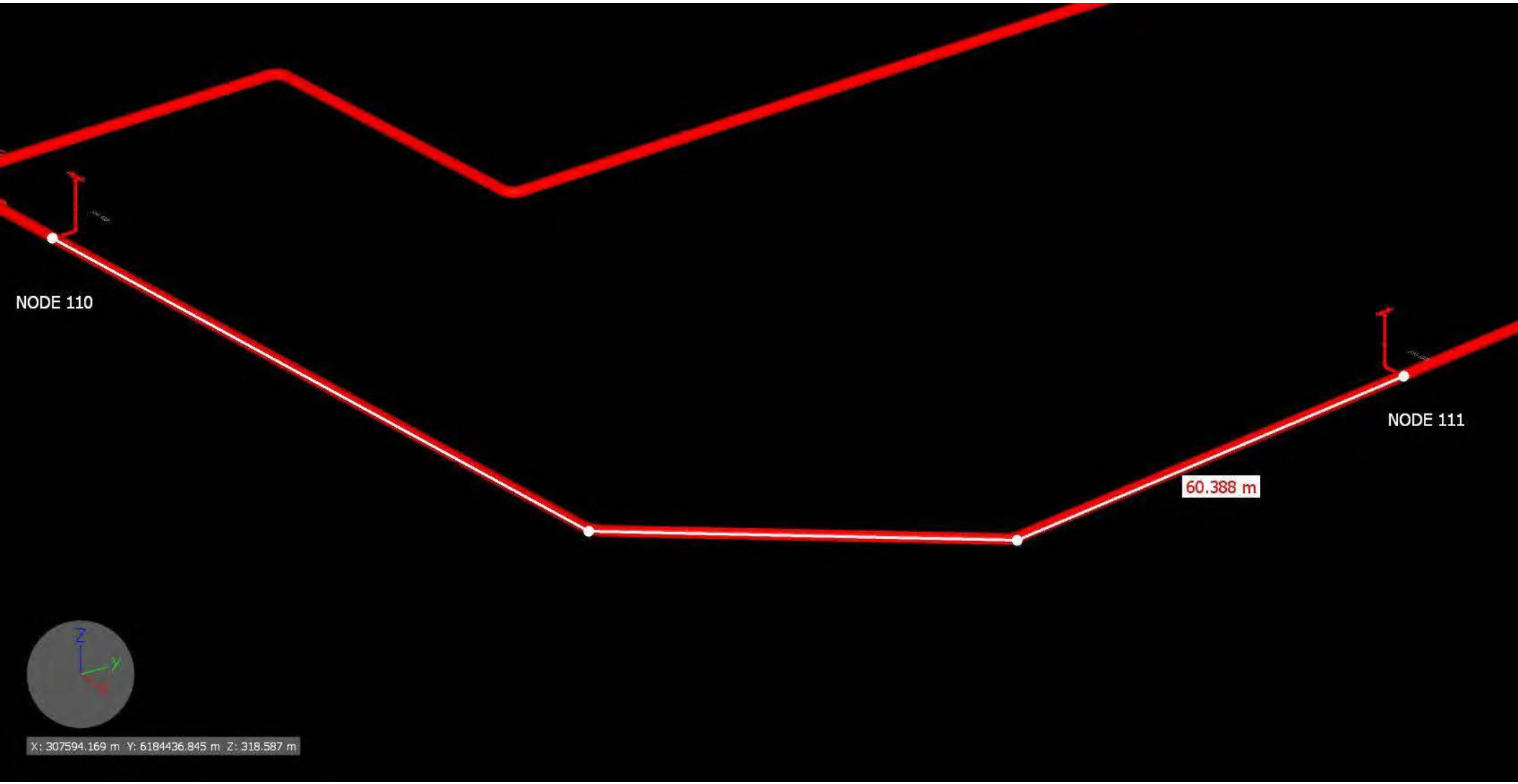

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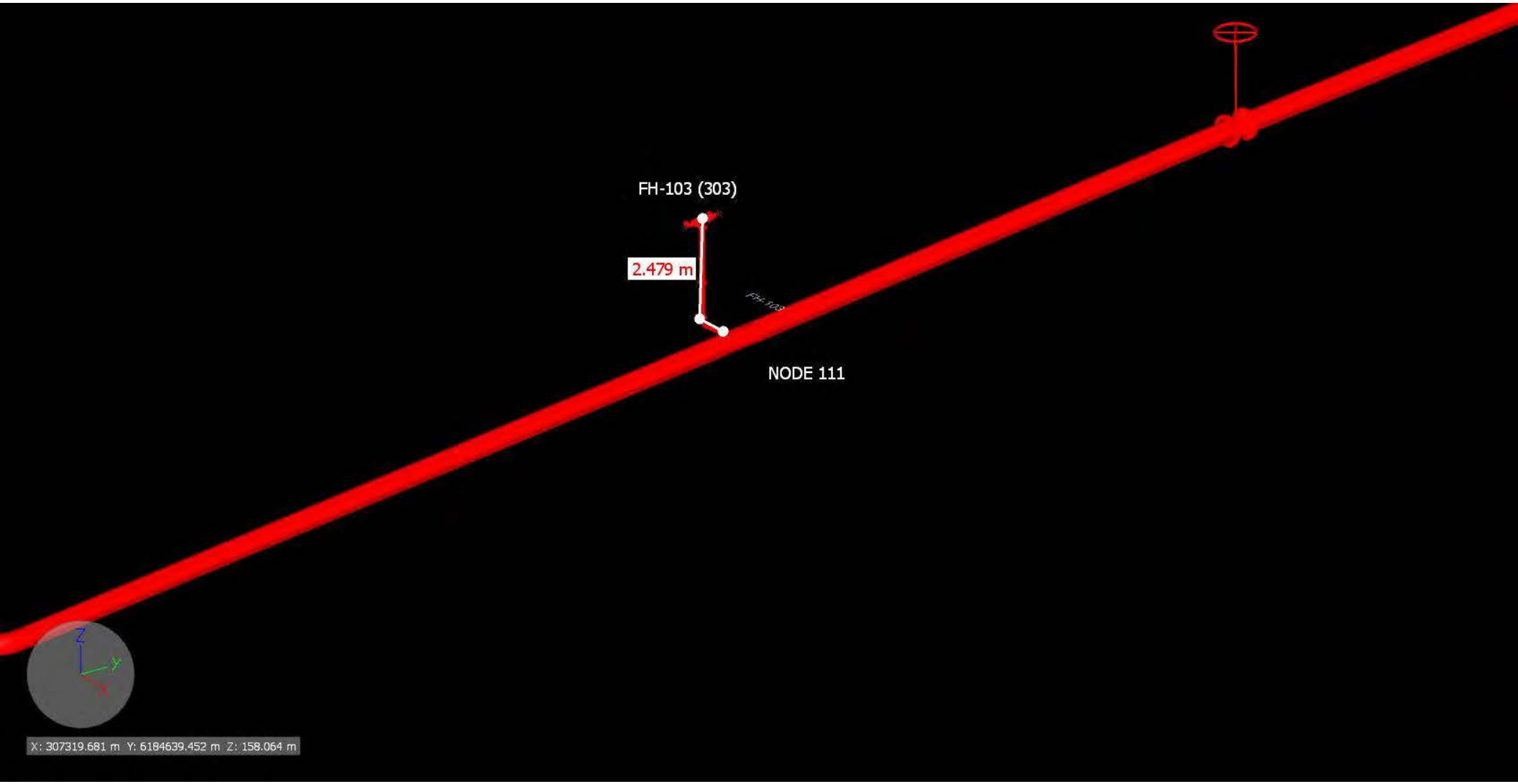
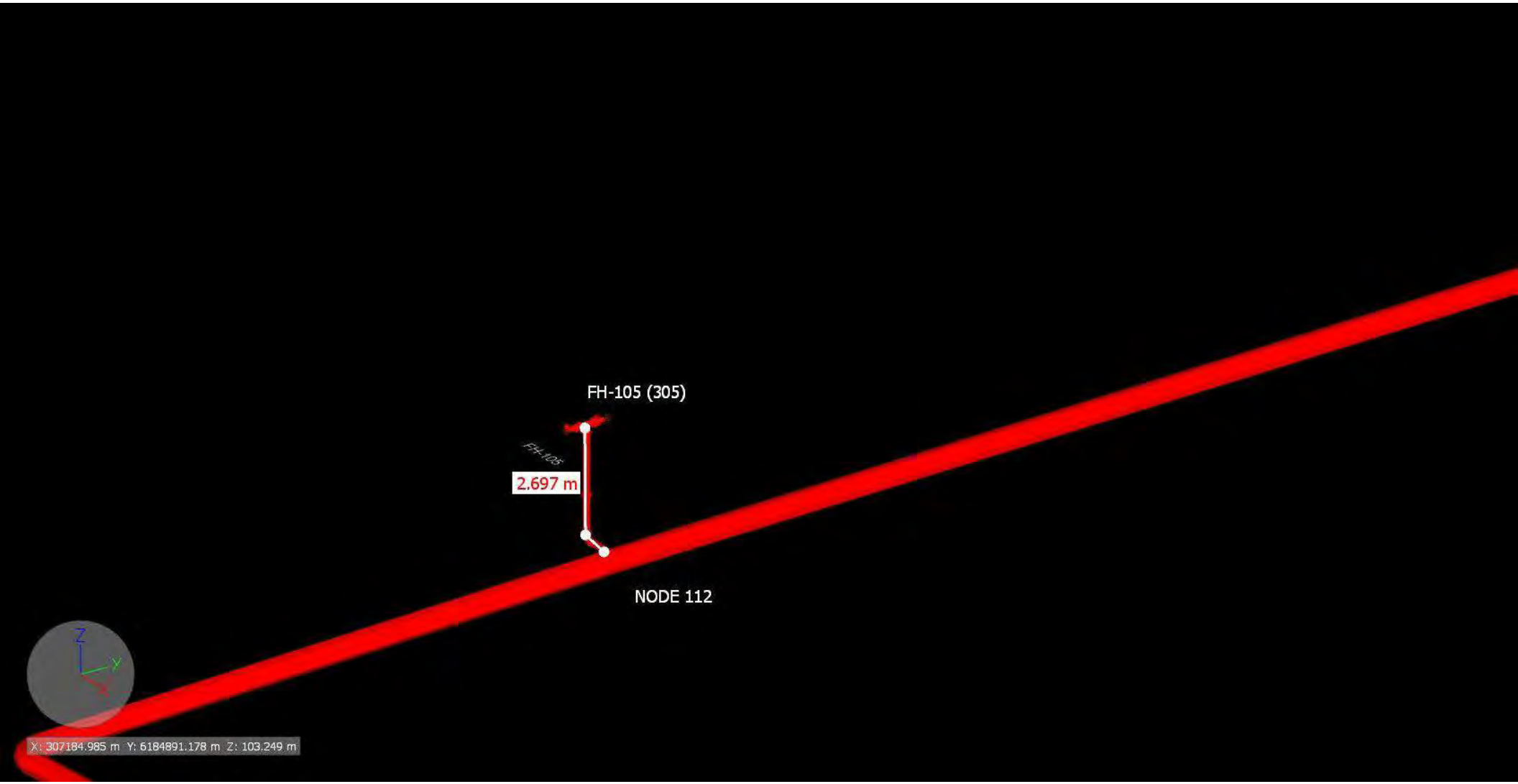


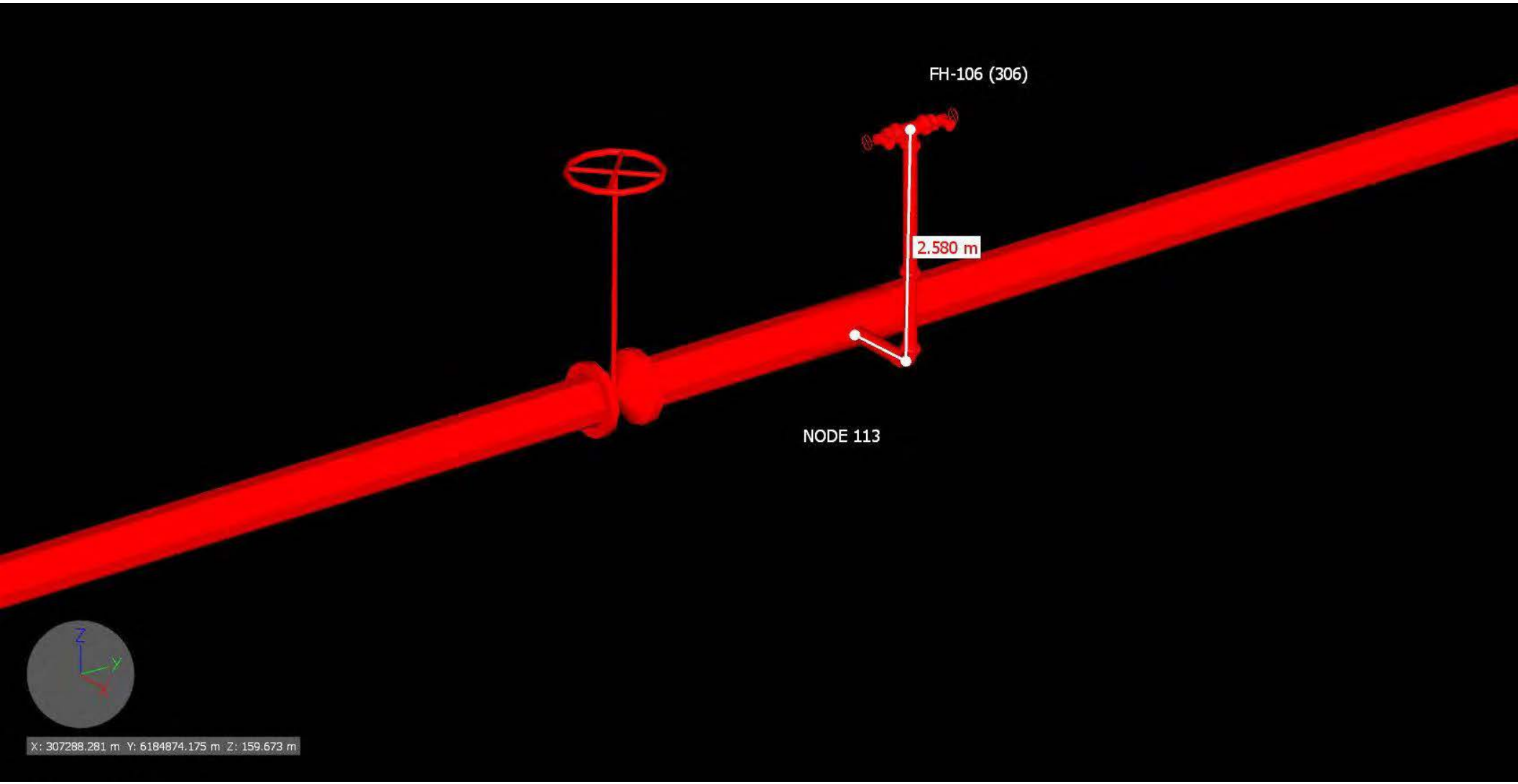
NODE 111 TO 112

NODE 112 TO 305



NODE 112 TO 113

NODE 113 TO 306



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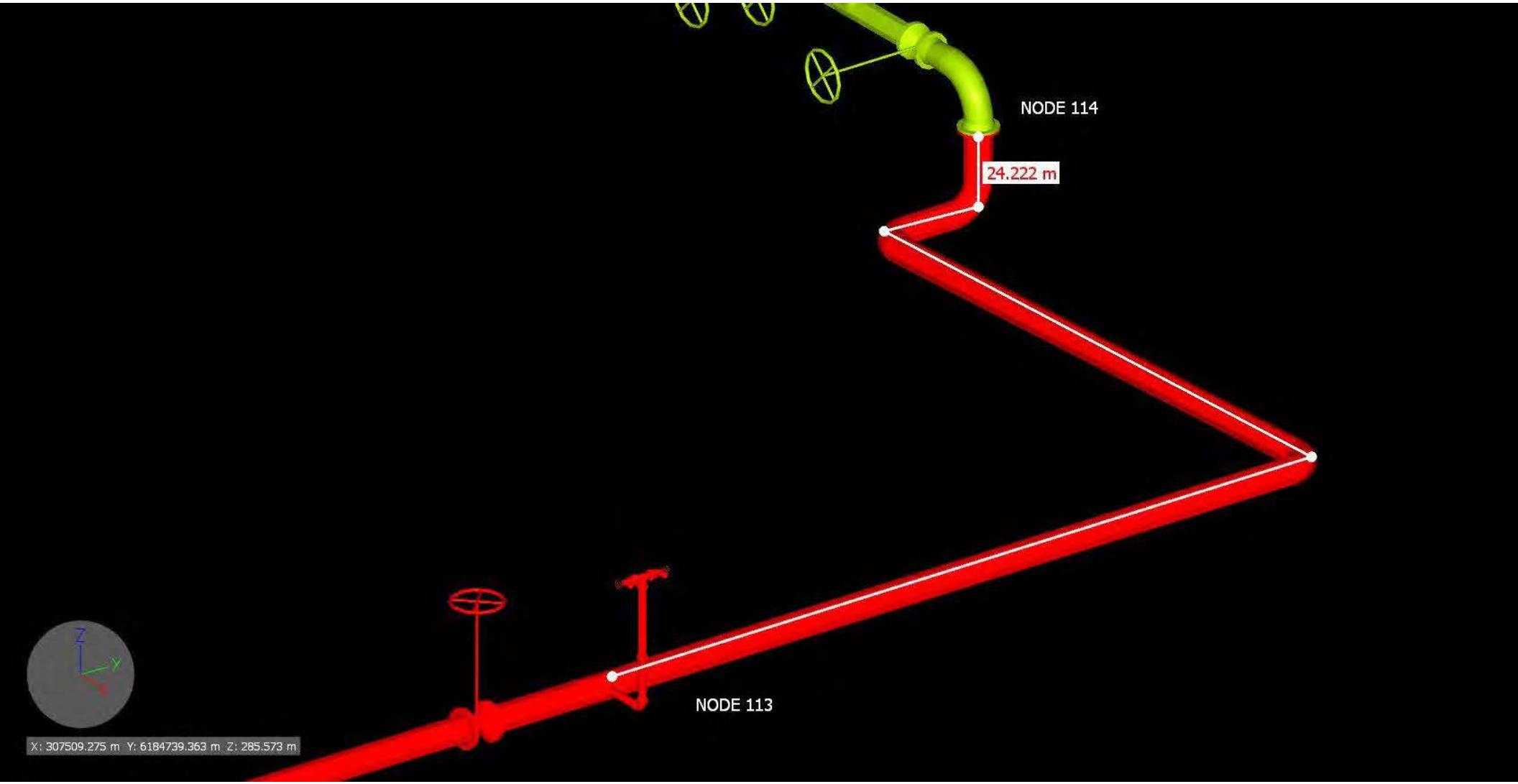

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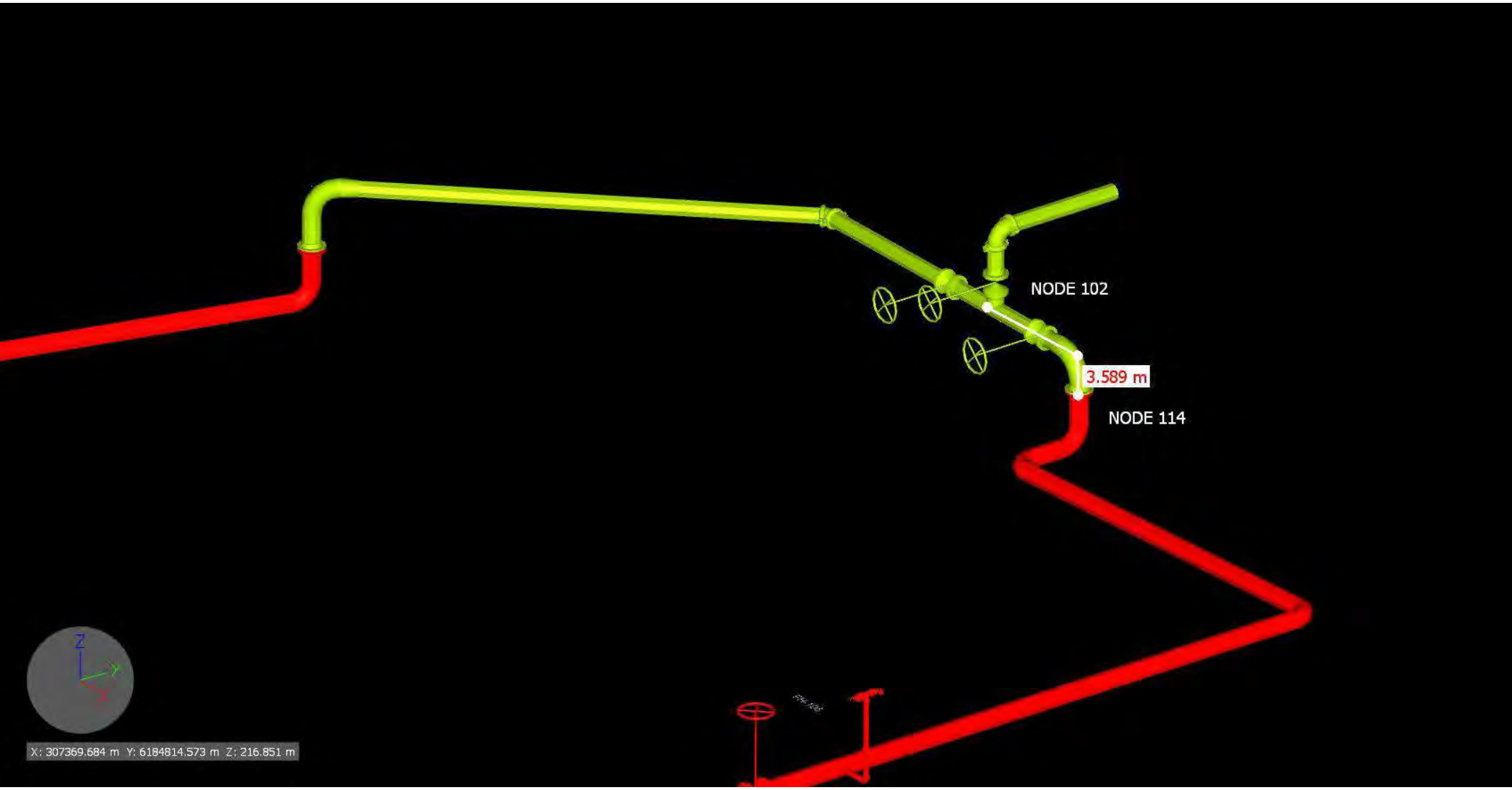

THE ACADS-BSG PROGRAM

HYENA

VERSION 7.0.0

ACADS BSG advises that the program HYENA is intended to be used only by persons who are proficient in its use and application, and that these results should be verified independently. The results must not be used without user acceptance of the ACADS-BSG's License Agreement for this program.

DESIGN PROGRAM FOR FIRE SPRINKLER, FIRE HYDRANT AND FIRE HOSE REEL SYSTEMS

Calculation build number 7.0.0D

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

DESIGN DATA AND SUMMARY RESULTS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:22**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Maximum unbalanced pressure is = 0.00000 kPa and occurs in Pipe Loop 2
Maximum node unbalanced flow is = 0.00000 l/m and occurs at node 102
Maximum loop unbalanced flow is = 0.00471 l/m and occurs in Pipe Loop 3

Fittings Specified as NFPA
Calculate Input Flow and Pressure to achieve Minimum Discharge Flows

Hazen-Williams formula used

Number of Nozzles Operating : 2
Total water flow for Nozzles : 12842 l/m
Average Flow 6421 l/m
Minimum Flow 6407 l/m

Balancing Devices

The calculated size and/or pressure drop of orifice plates is based on data listed in the Australian Standard AS2118 Part 1 Automatic Fire Sprinkler Systems.

Pipe No	Description	Input	Calculated	
401	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop	152.8 mm
402	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop	152.6 mm

Required Flow & Pressure, Input Node 101 : 12842 l/m at 1000 kPa

Specified available pressure at input node 101 : 1089 kPa
Available pressure minus required pressure is : 88.6 kPa

Pressure at zero flow 215.50 kPa - Smallest elevation difference between discharges and input points

Calculated Total Pipe Volume is : 59720 Litres

Approving Authority :
Certification Number :

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

Input Data

```
LABL1=Approving Authority
TEXT1=
LABL2=Certification Number
TEXT2=
OCC=
DENS=
AREA=
ORIF=
COVER=
NOPLOT
PLEN=M
PDIAM=MM
PRESSURE=KPA
FLOW=L/MIN
ELEV=M
FITTING=NFPA
REPORT
EQ
FDESPT   101
MAXV=4
VEL
\ Fitting Type =Comm
\ Defaults for HDPE Elbows/Tees= SE TT
\
\ Pipes
\ Pipes Mtr and Coef: Defaults= MCASAM HW140
P  1 101 102 4.7 350 AS20120  ZGV(1.83) SEPK TTPK
P  2 102 103 16.9 350 AS20120  HEPK ZGV(1.83) SEPK
P  3 103 104 187.2 400 PE11140  WHE1 5WSB 1SQWT
P  301 104 301 2.8 100 AS40120
P  4 104 105 36.6 400 PE11140  SQWT ZHGV(2.93)
P  401 105 401 28.5 200 AS40120  ZBV(3.66) OD(15) 6SEPK
P  5 105 106 43.2 400 PE11140  ZHGV(2.93) WSB SQWT
P  6 106 107 11.2 125 PE11140  WSB
P  304 107 304 2.1 100 AS40120
P  7 106 108 58.2 400 PE11140  ZHGV(2.93) 2WSB SQWT
P  8 108 109 13.4 250 PE11140  1WSB
P  402 109 402 24 200 AS40120  ZBV(3.66) OD(15) 5SEPK
P  9 108 110 6 400 PE11140  ZHGV(2.93) SQWT
P  302 110 302 2.9 100 AS40120
P  10 110 111 60.4 400 PE11140  2WSB 1SQWT
P  303 111 303 2.5 100 AS40120
P  11 111 112 193 400 PE11140  ZHGV(2.93) 3WSB SQWT
P  305 112 305 2.7 100 AS40120
P  12 112 113 53.7 400 PE11140  SQWT
P  306 113 306 2.7 100 AS40120
P  13 113 114 24.2 400 PE11140  3WSB
P  14 114 102 3.5 350 AS20120  ZGV(1.83) SEPK
\Discharges Default= ED24 PE0.5
\Hydrants Default=  HE1.2 HD300 HI700 HA1200
\
\ Nozzles
N  401        24   6404    242    0.5
N  402        24   6404    242    0.5
\
\ Hydrants
H  301       1.2    300    700   1200 NOP
H  304       1.2    600    700   1200 NOP
H  302       1.2    600    700   1200 NOP
H  303       1.2    300    700   1200 NOP
H  305       1.2    300    700   1200 NOP
H  306       1.2    300    700   1200 NOP
\
\ Reference Points
\Reference Point Default= ED-1
R  102       1.2
R  104        -1
R  105        -1
R  106        -1
R  107        -1
R  108        -1
R  109        -1
R  110        -1
R  111        -1
```

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

```
R  112        -1
R  113        -1
R  114       1.2
R  103        -1
\
\ InputPoints
IQ 101 2 0 1540 12612 1100 16683 880
END

                    LENGTH   DIAMETER    FLOW      HEAD   ELEVATION  PRESSURE
UNITS BEING USED:   METERS       MM      l/m        CM      METERS      KPA

ITERATION STOPS WHEN GREATEST FLOW CHANGE IS 1.28 IN ANY PIPE

THERE ARE    0 SPRINKLERS    2 NOZZLES and    0 BOOSTER PUMPS

THERE ARE   22 PIPES AND   19 REFERENCE POINTS

THE NUMBER OF INPUT POINTS IN SYSTEM IS    1

NODE   NO. OF PUMPS    PUMP      INPUT      PUMP PARAMETERS
 NO.   IN PARALLEL   ELEVATION  FRACTION    OR X-Y COORDINATES
 101          1          2.00       1.00      0.0 12612.0 16683.0
                                             1540.0  1100.0   880.0

Initial estimate of demand on the system is 12808.00

     NET UNBALANCED DEMAND ON THE SYSTEM IS 0
```

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

FITTING EQUIVALENT PIPE LENGTHS IN METERS Diameter in mm

	15	20	25	32	40	50	65	80	90	100	125	150	200	225	250	300	350	375
NFPA Steel Valves etc. in Schedule 40 to ASTM A-153, A-795 pipe with C=120																		
GV	.30	.30	.30	.30	.30	.30	.30	.30	.30	.61	.61	.91	1.22	1.37	1.52	1.83	1.83	1.98
CV			1.52	2.13	2.74	3.35	4.27	4.88	5.79	6.71	8.23	9.75	13.7	15.2	16.8	19.8	21.3	22.1
LV	4.88	6.10	7.62	10.4	12.5	16.2	18.6	24.4	27.4	30.8	36.6	48.8	64.0	76.2	88.4	104		
NV	2.44	3.35	3.96	5.49	6.40	8.23	9.75	12.2	14.3	16.8	18.3	25.0	32.0	38.1	44.2	51.8		
BV						1.83	2.13	3.05	3.35	3.66	2.74	3.05	3.66	4.72	5.79	6.40		
AV			.02	.06	.12	.37	.91	2.44	3.05	3.66	4.57	6.10	9.75					
MV										12.8		21.4	32.0		42.7			
DV			.03	.06	.15	.46	1.07	3.05	3.66	5.49	6.10	9.14						
SR			.03	.12	.23	.76	1.83	5.18	6.10	9.14	10.7	12.2	21.3					

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

FITTING EQUIVALENT PIPE LENGTHS IN METERS Diameter in mm

	L/D	20	25	32	40	50	63	75	90	110	125	140	160	180	200	225	250	280	315
Welded Bends and Tees in Polyethylene SDR11 to AN/NZS 4130 pipe with C=150																			
WSB	69	1.11	1.39	1.79	2.23	2.79	3.52	4.21	5.04	6.17	7.00	7.86	8.90	10.1	11.2	12.6	14.0	15.7	17.7
WE1	23	.37	.46	.60	.74	.93	1.17	1.40	1.68	2.06	2.33	2.62	2.97	3.36	3.74	4.21	4.68	5.24	5.89
WE15	17	.27	.34	.44	.55	.69	.87	1.04	1.24	1.52	1.73	1.94	2.19	2.49	2.76	3.11	3.46	3.87	4.36
WE2	14	.22	.28	.36	.45	.57	.71	.85	1.02	1.25	1.42	1.59	1.81	2.05	2.27	2.56	2.85	3.19	3.59
WHE1	17	.27	.34	.44	.55	.69	.87	1.04	1.24	1.52	1.73	1.94	2.19	2.49	2.76	3.11	3.46	3.87	4.36
WHE15	12	.19	.24	.31	.39	.49	.61	.73	.88	1.07	1.22	1.37	1.55	1.76	1.95	2.19	2.44	2.73	3.08
SQWT	87	1.40	1.75	2.26	2.81	3.52	4.44	5.30	6.36	7.78	8.83	9.90	11.2	12.7	14.1	15.9	17.7	19.8	22.3
WTT	60	.96	1.21	1.56	1.94	2.43	3.06	3.66	4.38	5.36	6.09	6.83	7.74	8.78	9.75	11.0	12.2	13.7	15.4
WTN	20	.32	.40	.52	.65	.81	1.02	1.22	1.46	1.79	2.03	2.28	2.58	2.93	3.25	3.66	4.07	4.56	5.13
Valves and Strainer in Polyethylene SDR11 to AN/NZS 4130 pipe with C=150																			
HLV	340	5.46	6.85	8.82	11.0	13.8	17.3	20.7	24.8	30.4	34.5	38.7	43.8	49.7	55.2	62.2	69.1	77.5	87.1
HGV	9	.14	.18	.23	.29	.36	.46	.55	.66	.80	.91	1.02	1.16	1.32	1.46	1.65	1.83	2.05	2.31
HBLF	3.3	.05	.07	.09	.11	.13	.17	.20	.24	.30	.33	.38	.43	.48	.54	.60	.67	.75	.85
HBLR	31	.50	.62	.80	1.00	1.25	1.58	1.89	2.26	2.77	3.15	3.53	4.00	4.53	5.04	5.67	6.30	7.06	7.94
HBV	40	.64	.81	1.04	1.29	1.62	2.04	2.44	2.92	3.58	4.06	4.55	5.16	5.85	6.50	7.31	8.13	9.11	10.3
HCV	135	2.17	2.72	3.50	4.36	5.46	6.89	8.23	9.86	12.1	13.7	15.4	17.4	19.7	21.9	24.7	27.5	30.8	34.6
HDCV	530	8.51	10.7	13.8	17.1	21.4	27.0	32.3	38.7	47.4	53.8	60.3	68.3	77.5	86.1	96.9	108	121	136
HNV	145	2.33	2.92	3.76	4.68	5.87	7.40	8.84	10.6	13.0	14.7	16.5	18.7	21.2	23.6	26.5	29.5	33.0	37.2
HLCV	700	11.2	14.1	18.2	22.6	28.3	35.7	42.7	51.1	62.6	71.1	79.7	90.3	102	114	128	142	159	179
HSTR	300	4.82	6.04	7.79	9.69	12.1	15.3	18.3	21.9	26.8	30.5	34.2	38.7	43.9	48.7	54.9	61.0	68.3	76.9

	L/D	355	400	450	500	560	630
Welded Bends and Tees in Polyethylene SDR11 to AN/NZS 4130 pipe with C=150							
WSB	69	19.9	22.5	25.3	28.1	31.4	35.4
WE1	23	6.64	7.48	8.42	9.36	10.5	11.8
WE15	17	4.91	5.53	6.22	6.91	7.75	8.71
WE2	14	4.04	4.56	5.12	5.69	6.38	7.18
WHE1	17	4.91	5.53	6.22	6.91	7.75	8.71
WHE15	12	3.47	3.90	4.39	4.88	5.47	6.15
SQWT	87	25.1	28.3	31.8	35.4	39.6	44.6
WTT	60	17.3	19.5	22.0	24.4	27.3	30.8
WTN	20	5.78	6.51	7.32	8.14	9.11	10.3
Valves and Strainer in Polyethylene SDR11 to AN/NZS 4130 pipe with C=150							
HLV	340	98.2	111	124	138	155	174
HGV	9	2.60	2.93	3.29	3.66	4.10	4.61
HBLF	3.3	.95	1.07	1.21	1.34	1.50	1.69
HBLR	31	8.95	10.1	11.3	12.6	14.1	15.9
HBV	40	11.6	13.0	14.6	16.3	18.2	20.5
HCV	135	39.0	43.9	49.4	54.9	61.5	69.2
HDCV	530	153	172	194	216	242	272
HNV	145	41.9	47.2	53.1	59.0	66.1	74.3
HLCV	700	202	228	256	285	319	359
HSTR	300	86.6	97.6	110	122	137	154

APPENDIX B – HYDRAULIC CALCULATION INPUT DATA

FITTING EQUIVALENT PIPE LENGTHS IN METERS Diameter in mm

	200	225	250	280	300	350	375	400	450	500	550	600	650	700	750	800	
User defined fittings with base Pipe Material and Hazen Williams Coefficient																	
SEPK	5.49				8.23	9.14											AS20 120
TTPK	10.7				18.3	19.8											AS20 120
HEPK	2.74				3.96	4.57											AS20 120

THE ACADS-BSG PROGRAM

HYENA

VERSION 7.0.0

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DESIGN PROGRAM FOR FIRE SPRINKLER, FIRE HYDRANT AND FIRE HOSE REEL SYSTEMS

Calculation build number 7.0.0D

APPENDIX C – HYDRAULIC CALCULATION- FULL RING

DESIGN DATA AND SUMMARY RESULTS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:22**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Maximum unbalanced pressure is = 0.00000 kPa and occurs in Pipe Loop 2
Maximum node unbalanced flow is = 0.00000 l/m and occurs at node 102
Maximum loop unbalanced flow is = 0.00471 l/m and occurs in Pipe Loop 3

Fittings Specified as NFPA
Calculate Input Flow and Pressure to achieve Minimum Discharge Flows

Hazen-Williams formula used

Number of Nozzles Operating : 2
Total water flow for Nozzles : 12842 l/m
Average Flow 6421 l/m
Minimum Flow 6407 l/m

Balancing Devices

The calculated size and/or pressure drop of orifice plates is based on data listed in the Australian Standard AS2118 Part 1 Automatic Fire Sprinkler Systems.

Pipe No	Description	Input	Calculated
401	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop 152.8 mm
402	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop 152.6 mm

Required Flow & Pressure, Input Node 101 : 12842 l/m at 1000 kPa

Specified available pressure at input node 101 : 1089 kPa
Available pressure minus required pressure is : 88.6 kPa

Pressure at zero flow 215.50 kPa - Smallest elevation difference between discharges and input points

Calculated Total Pipe Volume is : 59720 Litres

Approving Authority :
Certification Number :

PIPE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:22**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Pipe No.	Pipe node Numbers		Flow (l/m)	Pipe diam. Nom (mm)	Pipe diam. Actual (mm)	Pipe & Fitting CODE #	Length (m)	TOTAL Length (m)	Loss per m (KPa)	Pipe Loss (KPa)	Static Loss (KPa)	TOTAL Loss (KPa)	H&W Co-eff	Water Vel. (m/s)	Vel. Press (KPa)
1	101	102	12841.5	350	339.75	AS20	4.700	35.470	0.164	5.81	-7.84	-2.03	120	2.36	2.78
						1ZGV	1.830								
						1SEPK	9.140								
						1TTPK	19.800								
2	102	103	7102.8	350	339.75	AS20	16.900	32.440	0.055	1.77	-21.55	-19.78	120	1.31	0.85
						1HEPK	4.570								
						1ZGV	1.830								
						1SEPK	9.140								
3	103	104	7102.8	400	325.40	PE11	187.20	333.30	0.051	16.90	0.00	16.90	140	1.42	1.01
						1WHE1	5.532								
						5WSB	112.26								
						1SQWT	28.310								
4	104	105	7102.8	400	325.40	PE11	36.600	67.840	0.051	3.44	0.00	3.44	140	1.42	1.01
						1SQWT	28.310								
						1ZHGV	2.930								
5	105	106	668.6	400	325.40	PE11	43.200	96.892	0.00064	0.06	0.00	0.06	140	0.13	0.01
						1ZHGV	2.930								
						1WSB	22.453								
						1SQWT	28.310								
6	106	107	0.0	125	101.50	PE11	11.200	18.204	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1WSB	7.004								
7	106	108	668.6	400	325.40	PE11	58.200	134.34	0.00064	0.09	0.00	0.09	140	0.13	0.01
						1ZHGV	2.930								
						2WSB	44.905								
						1SQWT	28.310								
8	108	109	6407.3	250	203.35	PE11	13.400	27.431	0.414	11.34	0.00	11.34	140	3.29	5.40
						1WSB	14.031								
9	110	108	5738.7	400	325.40	PE11	6.000	37.240	0.034	1.27	0.00	1.27	140	1.15	0.66
						1ZHGV	2.930								
						1SQWT	28.310								
10	111	110	5738.7	400	325.40	PE11	60.400	133.61	0.034	4.56	0.00	4.56	140	1.15	0.66
						2WSB	44.905								
						1SQWT	28.310								
11	112	111	5738.7	400	325.40	PE11	193.00	291.60	0.034	9.96	0.00	9.96	140	1.15	0.66
						1ZHGV	2.930								
						3WSB	67.358								
						1SQWT	28.310								
12	113	112	5738.7	400	325.40	PE11	53.700	82.010	0.034	2.80	0.00	2.80	140	1.15	0.66
						1SQWT	28.310								
13	114	113	5738.7	400	325.40	PE11	24.200	91.558	0.034	3.13	-21.55	-18.42	140	1.15	0.66
						3WSB	67.358								
14	102	114	5738.7	350	339.75	AS20	3.500	14.470	0.037	0.53	0.00	0.53	120	1.05	0.56
						1ZGV	1.830								
						1SEPK	9.140								
301	104	301	0.0	100	102.26	AS40	2.800	2.800	0.00000	0.00	21.55	21.55	120	0.00	0.00
302	110	302	0.0	100	102.26	AS40	2.900	2.900	0.00000	0.00	21.55	21.55	120	0.00	0.00
303	111	303	0.0	100	102.26	AS40	2.500	2.500	0.00000	0.00	21.55	21.55	120	0.00	0.00
304	107	304	0.0	100	102.26	AS40	2.100	2.100	0.00000	0.00	21.55	21.55	120	0.00	0.00
305	112	305	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	21.55	21.55	120	0.00	0.00
306	113	306	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	21.55	21.55	120	0.00	0.00
401	105	401	6434.2	200	202.72	AS40	28.500	62.335	0.563	35.09	244.88	294.97	120	3.32	5.51
						1ZBV	3.660								
					206.40	6SEPK	30.175								
						1OD Orifice(Fixed P.Drop)				15.00					
402	109	402	6407.3	200	202.72	AS40	24.000	52.806	0.559	29.49	244.88	289.38	120	3.31	5.47
						1ZBV	3.660								
					206.40	5SEPK	25.146								
						1OD Orifice(Fixed P.Drop)				15.00					

LEGEND - Fittings and Pipe Materials used in this run

Standard Fittings

GV = Gate Valve	BV = Butterfly Valve	WSB = 90 deg Sharp Welded Bend
WHE1 = 45 deg Welded Elbow R/D=1	SQWT = Square Welded Tee Branch	HGV = Gate Valve fully open

User Fittings
SEPK = PKGT
TTPK = PKGT
HEPK = PKGT

Standard Pipe Materials
AS20 = Schedule 20 Steel to ASTM A-135, A-795
AS40 = Schedule 40 Medium Weight Steel to ASTM A-135, A-795
PE11 = Polyethylene SDR11 to AN/NZS 4130

*** WARNING : THE FOLLOWING PIPES (EXCLUDING SPRINKLER RISERS/DROPPERS) HAVE FLOWS SMALLER THAN 0.1 l/m
6 301 302 303 304 305 306

Maximum unbalanced pressure is = 0.00000 kPa and occurs in Pipe Loop 2
Maximum loop unbalanced flow is = 0.00471 l/m and occurs in Pipe Loop 3
Maximum node unbalanced flow is = 0.00000 l/m

NODE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:22**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Input Node 101 : 12841.5 l/m 1000.40 kPa 2.000 m elevation

Node No	Node Type		--- Flow l/m --- calc'ed	min	-------- Pressure kPa ---------- total	normal	min	max	Elev. m	K-Factor l/m	Exp kPa
102					1002.44				1.200		
103					1022.21				-1.000		
104					1005.31				-1.000		
105					1001.87				-1.000		
106					1001.81				-1.000		
107					1001.81				-1.000		
108					1001.73				-1.000		
109					990.38				-1.000		
110					1003.00				-1.000		
111					1007.56				-1.000		
112					1017.52				-1.000		
113					1020.32				-1.000		
114					1001.90				1.200		
301	Hydrant	Nop			983.76				1.200		
302	Hydrant	Nop			981.45				1.200		
303	Hydrant	Nop			986.01				1.200		
304	Hydrant	Nop			980.26				1.200		
305	Hydrant	Nop			995.97				1.200		
306	Hydrant	Nop			998.78				1.200		
401	Nozzle		6434.2	6404.00	706.90				24.000	242.0	0.50
402	**Nozzle**		**6407.3**	**6404.00**	**701.01**				**24.000**	**242.0**	**0.50**

NOTES:
normal pressure - is the total pressure minus the velocity pressure

THE ACADS-BSG PROGRAM

HYENA

VERSION 7.0.0

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DESIGN PROGRAM FOR FIRE SPRINKLER, FIRE HYDRANT AND FIRE HOSE REEL SYSTEMS

Calculation build number 7.0.0D

APPENDIX D – HYDRAULIC CALCULATION- HALF RING

DESIGN DATA AND SUMMARY RESULTS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:28**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Maximum unbalanced pressure is = 0.00000 kPa
Maximum node unbalanced flow is = 0.00000 l/m
Maximum loop unbalanced flow is = 0.00014 l/m and occurs in Pipe Loop 1

Fittings Specified as NFPA
Calculate Input Flow and Pressure to achieve Minimum Discharge Flows

Hazen-Williams formula used

Number of Nozzles Operating : 2
Total water flow for Nozzles : 12832 l/m
Average Flow 6416 l/m
Minimum Flow 6408 l/m

Balancing Devices

The calculated size and/or pressure drop of orifice plates is based on data listed in the Australian Standard AS2118 Part 1 Automatic Fire Sprinkler Systems.

Pipe No	Description	Input	Calculated
401	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop 152.6 mm
402	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop 152.6 mm

Required Flow & Pressure, Input Node 101 : 12832 l/m at 1081 kPa

Specified available pressure at input node 101 : 1089 kPa
Available pressure minus required pressure is : 8.64 kPa

Pressure at zero flow 215.50 kPa - Smallest elevation difference between discharges and input points

Calculated Total Pipe Volume is : 58187 Litres

Approving Authority :
Certification Number :

PIPE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:28**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Pipe No.	Pipe node Numbers		Flow (l/m)	Pipe diam. Nom (mm)	Pipe diam. Actual (mm)	Pipe & Fitting CODE #	Length (m)	TOTAL Length (m)	Loss per m (KPa)	Pipe Loss (KPa)	Static Loss (KPa)	TOTAL Loss (KPa)	H&W Co-eff	Water Vel. (m/s)	Vel. Press (KPa)
1	101	102	12832.3	350	339.75	AS20	4.700	35.470	0.163	5.80	-7.84	-2.04	120	2.36	2.78
						1ZGV	1.830								
						1SEPK	9.140								
						1TTPK	19.800								
3	103	104	0.0	400	325.40	PE11	187.20	333.30	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1WHE1	5.532								
						5WSB	112.26								
						1SQWT	28.310								
4	104	105	0.0	400	325.40	PE11	36.600	67.840	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1SQWT	28.310								
						1ZHGV	2.930								
5	106	105	6408.2	400	325.40	PE11	43.200	96.892	0.042	4.06	0.00	4.06	140	1.28	0.82
						1ZHGV	2.930								
						1WSB	22.453								
						1SQWT	28.310								
6	106	107	0.0	125	101.50	PE11	11.200	18.204	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1WSB	7.004								
7	108	106	6408.2	400	325.40	PE11	58.200	134.34	0.042	5.63	0.00	5.63	140	1.28	0.82
						1ZHGV	2.930								
						2WSB	44.905								
						1SQWT	28.310								
8	108	109	6424.1	250	203.35	PE11	13.400	27.431	0.416	11.40	0.00	11.40	140	3.30	5.43
						1WSB	14.031								
9	110	108	12832.3	400	325.40	PE11	6.000	37.240	0.152	5.65	0.00	5.65	140	2.57	3.30
						1ZHGV	2.930								
						1SQWT	28.310								
10	111	110	12832.3	400	325.40	PE11	60.400	133.61	0.152	20.26	0.00	20.26	140	2.57	3.30
						2WSB	44.905								
						1SQWT	28.310								
11	112	111	12832.3	400	325.40	PE11	193.00	291.60	0.152	44.21	0.00	44.21	140	2.57	3.30
						1ZHGV	2.930								
						3WSB	67.358								
						1SQWT	28.310								
12	113	112	12832.3	400	325.40	PE11	53.700	82.010	0.152	12.43	0.00	12.43	140	2.57	3.30
						1SQWT	28.310								
13	114	113	12832.3	400	325.40	PE11	24.200	91.558	0.152	13.88	-21.55	-7.67	140	2.57	3.30
						3WSB	67.358								
14	102	114	12832.3	350	339.75	AS20	3.500	14.470	0.163	2.37	0.00	2.37	120	2.36	2.78
						1ZGV	1.830								
						1SEPK	9.140								
301	104	301	0.0	100	102.26	AS40	2.800	2.800	0.00000	0.00	21.55	21.55	120	0.00	0.00
302	110	302	0.0	100	102.26	AS40	2.900	2.900	0.00000	0.00	21.55	21.55	120	0.00	0.00
303	111	303	0.0	100	102.26	AS40	2.500	2.500	0.00000	0.00	21.55	21.55	120	0.00	0.00
304	107	304	0.0	100	102.26	AS40	2.100	2.100	0.00000	0.00	21.55	21.55	120	0.00	0.00
305	112	305	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	21.55	21.55	120	0.00	0.00
306	113	306	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	21.55	21.55	120	0.00	0.00
401	105	401	6408.2	200	202.72	AS40	28.500	62.335	0.559	34.83	244.88	294.71	120	3.31	5.47
						1ZBV	3.660								
					206.40	6SEPK	30.175								
						1OD Orifice(Fixed P.Drop)				15.00					
402	109	402	6424.1	200	202.72	AS40	24.000	52.806	0.561	29.64	244.88	289.52	120	3.32	5.50
						1ZBV	3.660								
					206.40	5SEPK	25.146								
						1OD Orifice(Fixed P.Drop)				15.00					

LEGEND - Fittings and Pipe Materials used in this run

Standard Fittings

GV	= Gate Valve	BV	= Butterfly Valve	WSB	= 90 deg Sharp Welded Bend
WHE1	= 45 deg Welded Elbow R/D=1	SQWT	= Square Welded Tee Branch	HGV	= Gate Valve fully open

User Fittings

PIPE CHARACTERISTICS

Pipe No.	Pipe node Numbers	Flow (l/m)	Pipe diam. Nom (mm)	Pipe diam. Actual (mm)	Fitting CODE #	Pipe & Fitting Length (m)	TOTAL Length (m)	Loss per m (KPa)	Pipe Loss (KPa)	Static Loss (KPa)	TOTAL Loss (KPa)	H&W Co-eff (	Water Vel. m/s)	Vel. Press (KPa)

SEPK = PKGT
TTPK = PKGT

Standard Pipe Materials
AS20 = Schedule 20 Steel to ASTM A-135, A-795
AS40 = Schedule 40 Medium Weight Steel to ASTM A-135, A-795
PE11 = Polyethylene SDR11 to AN/NZS 4130

*** WARNING : THE FOLLOWING PIPES (EXCLUDING SPRINKLER RISERS/DROPPERS) HAVE FLOWS SMALLER THAN 0.1 l/m
3 4 6 301 302 303 304 305 306

Maximum unbalanced pressure is = 0.00000 kPa
Maximum loop unbalanced flow is = 0.00014 l/m and occurs in Pipe Loop 1
Maximum node unbalanced flow is = 0.00000 l/m

NODE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:28**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Input Node 101 : 12832.3 l/m 1080.79 kPa 2.000 m elevation

Node No	Node Type	--- Flow l/m ---- calc'ed	min	Pressure kPa total	normal	min	max	Elev. m	K-Factor l/m	Exp kPa	
102				1082.83				1.200			
103				995.91				-1.000			
104				995.91				-1.000			
105				995.91				-1.000			
106				999.97				-1.000			
107				999.97				-1.000			
108				1005.60				-1.000			
109				994.20				-1.000			
110				1011.24				-1.000			
111				1031.50				-1.000			
112				1075.71				-1.000			
113				1088.14				-1.000			
114				1080.47				1.200			
301	Hydrant Nop			974.36				1.200			
302	Hydrant Nop			989.69				1.200			
303	Hydrant Nop			1009.95				1.200			
304	Hydrant Nop			978.42				1.200			
305	Hydrant Nop			1054.16				1.200			
306	Hydrant Nop			1066.59				1.200			
401	**Nozzle**	**6408.2**	**6404.00**	**701.20**				**24.000**	**242.0**	**0.50**	
402	Nozzle	6424.1	6404.00	704.68				24.000	242.0	0.50	

NOTES:
normal pressure - is the total pressure minus the velocity pressure

THE ACADS-BSG PROGRAM

HYENA

VERSION 7.0.0

ACADS BSG advises that the program HYENA is intended to be used only by persons who are proficient in its use and application, and that these results should be verified independently. The results must not be used without user acceptance of the ACADS-BSG's License Agreement for this program.

DESIGN PROGRAM FOR FIRE SPRINKLER, FIRE HYDRANT AND FIRE HOSE REEL SYSTEMS

Calculation build number 7.0.0D

APPENDIX E – HYDRAULIC CALCULATION- PRESSURE LOSS FOR BOOSTING CONDITION

DESIGN DATA AND SUMMARY RESULTS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:41**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Maximum unbalanced pressure is = 0.00000 kPa and occurs in Pipe Loop 2
Maximum node unbalanced flow is = 0.00000 l/m and occurs at node 102
Maximum loop unbalanced flow is = 0.00008 l/m and occurs in Pipe Loop 1

Fittings Specified as NFPA
Calculate Input Flow and Pressure to achieve Minimum Discharge Flows

Hazen-Williams formula used

Number of Hydrants Operating : 1
Total water flow for Hydrants : 600 l/m

Balancing Devices

The calculated size and/or pressure drop of orifice plates is based on data listed in the Australian Standard AS2118 Part 1 Automatic Fire Sprinkler Systems.

Pipe No	Description	Input	Calculated	
401	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop	0.0 mm
402	(OD) Orifice Plate fixed P.Drop:	15.00 kPa	15.00 kPa drop	0.0 mm

Required Flow & Pressure, Input Node 101 : 600 l/m at 701 kPa

Specified available pressure at input node 101 : 1538 kPa
Available pressure minus required pressure is : 837 kPa

Pressure at zero flow 0.00 kPa - Smallest elevation difference between discharges and input points

Calculated Total Pipe Volume is : 59720 Litres

Approving Authority :
Certification Number :

PIPE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:41**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Pipe No.	Pipe node Numbers		Flow (l/m)	Pipe diam. Nom (mm)	Pipe diam. Actual (mm)	Pipe & Fitting CODE #	Length (m)	TOTAL Length (m)	Loss per m (KPa)	Pipe Loss (KPa)	Static Loss (KPa)	TOTAL Loss (KPa)	H&W Co-eff	Water Vel. (m/s)	Vel. Press (KPa)
1	101	102	600.3	350	339.75	AS20	4.700	35.470	0.00056	0.02	-7.84	-7.82	120	0.11	0.01
						1ZGV	1.830								
						1SEPK	9.140								
						1TTPK	19.800								
2	102	103	289.1	350	339.75	AS20	16.900	32.440	0.00015	0.00	-21.55	-21.54	120	0.05	0.00
						1HEPK	4.570								
						1ZGV	1.830								
						1SEPK	9.140								
3	103	104	289.1	400	325.40	PE11	187.20	333.30	0.00013	0.04	0.00	0.04	140	0.06	0.00
						1WHE1	5.532								
						5WSB	112.26								
						1SQWT	28.310								
4	104	105	289.1	400	325.40	PE11	36.600	67.840	0.00013	0.01	0.00	0.01	140	0.06	0.00
						1SQWT	28.310								
						1ZHGV	2.930								
5	105	106	289.1	400	325.40	PE11	43.200	96.892	0.00013	0.01	0.00	0.01	140	0.06	0.00
						1ZHGV	2.930								
						1WSB	22.453								
						1SQWT	28.310								
6	106	107	0.0	125	101.50	PE11	11.200	18.204	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1WSB	7.004								
7	106	108	289.1	400	325.40	PE11	58.200	134.34	0.00013	0.02	0.00	0.02	140	0.06	0.00
						1ZHGV	2.930								
						2WSB	44.905								
						1SQWT	28.310								
8	108	109	0.0	250	203.35	PE11	13.400	27.431	0.00000	0.00	0.00	0.00	140	0.00	0.00
						1WSB	14.031								
9	108	110	289.1	400	325.40	PE11	6.000	37.240	0.00013	0.01	0.00	0.01	140	0.06	0.00
						1ZHGV	2.930								
						1SQWT	28.310								
10	111	110	311.3	400	325.40	PE11	60.400	133.61	0.00015	0.02	0.00	0.02	140	0.06	0.00
						2WSB	44.905								
						1SQWT	28.310								
11	112	111	311.3	400	325.40	PE11	193.00	291.60	0.00015	0.05	0.00	0.05	140	0.06	0.00
						1ZHGV	2.930								
						3WSB	67.358								
						1SQWT	28.310								
12	113	112	311.3	400	325.40	PE11	53.700	82.010	0.00015	0.01	0.00	0.01	140	0.06	0.00
						1SQWT	28.310								
13	114	113	311.3	400	325.40	PE11	24.200	91.558	0.00015	0.01	-21.55	-21.54	140	0.06	0.00
						3WSB	67.358								
14	102	114	311.3	350	339.75	AS20	3.500	14.470	0.00017	0.00	0.00	0.00	120	0.06	0.00
						1ZGV	1.830								
						1SEPK	9.140								
301	104	301	0.0	100	102.26	AS40	2.800	2.800	0.00000	0.00	29.39	29.39	120	0.00	0.00
302	110	302	600.3	100	102.26	AS40	2.900	2.900	0.195	0.57	29.39	29.95	120	1.22	0.74
303	111	303	0.0	100	102.26	AS40	2.500	2.500	0.00000	0.00	29.39	29.39	120	0.00	0.00
304	107	304	0.0	100	102.26	AS40	2.100	2.100	0.00000	0.00	29.39	29.39	120	0.00	0.00
305	112	305	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	29.39	29.39	120	0.00	0.00
306	113	306	0.0	100	102.26	AS40	2.700	2.700	0.00000	0.00	29.39	29.39	120	0.00	0.00
401	105	401	0.0	200	202.72	AS40	28.500	62.335	0.00000	0.00	244.88	259.88	120	0.00	0.00
						1ZBV	3.660								
					206.40	6SEPK	30.175								
						1OD Orifice(Fixed P.Drop)				15.00					
402	109	402	0.0	200	202.72	AS40	24.000	52.806	0.00000	0.00	244.88	259.88	120	0.00	0.00
						1ZBV	3.660								
					206.40	5SEPK	25.146								
						1OD Orifice(Fixed P.Drop)				15.00					

1

LEGEND - Fittings and Pipe Materials used in this run

Standard Fittings

GV	= Gate Valve	BV	= Butterfly Valve	WSB	= 90 deg Sharp Welded Bend
WHE1	= 45 deg Welded Elbow R/D=1	SQWT	= Square Welded Tee Branch	HGV	= Gate Valve fully open

User Fittings
SEPK = PKGT
TTPK = PKGT
HEPK = PKGT

Standard Pipe Materials
AS20 = Schedule 20 Steel to ASTM A-135, A-795
AS40 = Schedule 40 Medium Weight Steel to ASTM A-135, A-795
PE11 = Polyethylene SDR11 to AN/NZS 4130

*** WARNING : THE FOLLOWING PIPES (EXCLUDING SPRINKLER RISERS/DROPPERS) HAVE FLOWS SMALLER THAN 0.1 l/m
6 8 301 303 304 305 306 401 402

Maximum unbalanced pressure is = 0.00000 kPa and occurs in Pipe Loop 2
Maximum loop unbalanced flow is = 0.00008 l/m and occurs in Pipe Loop 1
Maximum node unbalanced flow is = 0.00000 l/m

NODE CHARACTERISTICS

Designer : FIRE ENGINEERING SOLUTIONS QLD **DATE :29 JUL 2022**
Client : AIE / LOGICAMMS **TIME : 12:41**
Project : 3821- PORT KEMBLA GAS TERMINAL- FIRE WATER DESIGN

Input Node 101 : 600.3 l/m 701.40 kPa 2.000 m elevation

Node No	Node Type		Flow l/m calc'ed	Flow l/m min	Pressure kPa total	Pressure kPa normal	Pressure kPa min	Pressure kPa max	Elev. m	K-Factor l/m kPa	K-Factor Exp
102					709.22				1.200		
103					730.77				-1.000		
104					730.72				-1.000		
105					730.71				-1.000		
106					730.70				-1.000		
107					730.70				-1.000		
108					730.68				-1.000		
109					730.68				-1.000		
110					730.68				-1.000		
111					730.70				-1.000		
112					730.74				-1.000		
113					730.75				-1.000		
114					709.22				1.200		
301	Hydrant	Nop			701.34				2.000		
302	**Hydrant**		**600.3**	**600.00**	**700.72**		**700.00**	**1200.00**	**2.000**		
303	Hydrant	Nop			701.31				2.000		
304	Hydrant	Nop			701.31				2.000		
305	Hydrant	Nop			701.36				2.000		
306	Hydrant	Nop			701.37				2.000		
401	Nozzle	Nop			470.83				24.000		
402	Nozzle	Nop			470.80				24.000		

NOTES:
normal pressure - is the total pressure minus the velocity pressure