UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS

JUDUL: **POTENTIAL NATURAL GAS PIPE LINE AT UNIVERSITI MALAYSIA PAHANG LABORATORY AND RESIDENTIAL COLLEGE UNIT FOR FUTURE DEVELOPMENT**

SESI PENGAJIAN: **2010/2011**

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Signature: ....

Supervisor's Name: **Madam Siti Zubaidah Binti Sulaiman**

Date:

POTENTIAL NATURAL GAS PIPE LINE AT UNIVERSITI MALAYSIA PAHANG LABORATORY AND RESIDENTIAL COLLEGE UNIT FOR FUTURE DEVELOPMENT

MUHAMMAD ARIF BIN ISMAIL

A thesis submitted in fulfillment
of the requirements for the award of the Degree of
Bachelor of Chemical Engineering (Gas Technology)

Faculty of Chemical & Natural Resources Engineering
University Malaysia Pahang

NOVEMBER 2010

I declare that this thesis entitled "**POTENTIAL NATURAL GAS PIPE LINE AT UNIVERSITI MALAYSIA PAHANG LABORATORY AND RESIDENTIAL COLLEGE UNIT FOR FUTURE DEVELOPMENT**" is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

Signature :

Name : **MUHAMMAD ARIF BIN ISMAIL**
Date : **1/12/2010**

DEDICATION

Special Dedication to my beloved parents, siblings and all my friends for their love and encouragement.

And,

Special Thanks to supervisor (Mdm Siti Zubaidah)

For all of your Care, Support and Best Wishes.

Sincerely,
MUHAMMAD ARIF BIN ISMAIL

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ABSTRAK

Penggunaan tenaga meningkat akibat pertumbuhan ekonomi yang pesat di Malaysia. Menyedari pentingnya tenaga, gas asli dapat menjadi sumber tenaga alternatif yang lebih berkesan dan murah berbanding dengan punca kuasa. Tujuan utama dari projek ini adalah untuk merancang pusat pengedaran gas asli untuk semua unit asrama pelajar di Universiti Malaysia Pahang (UMP) yang terletak di Gambang, Kuantan. UMP terletak berhampiran dengan stesen minyak perkhidmatan, sekitar 500 m dengan stesen perkhidmatan gas yang ada di Gambang, itu adalah cara mudah untuk ambil gas asli pada titik masa depan UMP. Saat ini, kantin pelajar menggunakan LPG untuk memasak dan tidak terus menerus bekalan dan boleh mengganggu pengeluaran mereka. Selain itu, mahasiswa juga mempunyai pemanas air di asrama mereka, sehingga akan mempengaruhi bil elektrik untuk setiap bulan. Ruang lingkup projek ini adalah pengambilan permintaan beban yang boleh menampung untuk semua unit kuliah perumahan dan kantin pelajar, perhitungan rangkaian paip dengan menggunakan persamaan Cox perhitungan beban dan menentukan klasifikasi pembinaan polyethylene paip, dan terakhir menggunakan software PDMS untuk merekacipta sistem paip. Kaedah yang digunakan adalah untuk mengira semua saiz paip dan permintaan gas beban dengan menggunakan persamaan Cox's menurut ASME B31.8 mengikut seperti MS930 dan ASME untuk memastikan bahawa sistem paip selamat untuk pembinaan. Akibatnya, penurunan jumlah tekanan dari sumber ke pengguna tidak melebihi 15% yang diterima untuk merancang paip. Medium Density polyethylene (MDPE) paip digunakan untuk pembangunan pusat pengedaran. Terkini, saiz paip untuk paip MDPE adalah 2 inci dan 3 inci. Sebagai kesimpulan, gas alam dapat mengurangkan sekitar 50% kos penggunaan dibandingkan dengan kuasa electric.

ABSTRACT

The consumption of energy has increased as result of rapid economic growth in Malaysia. Realizing the importance of energy, natural gas can be alternative energy source which is more effective and cheap compared to electricity. The main objective of this project is to design the distribution line of natural gas to all residential college units (UKK) at Universiti Malaysia Pahang (UMP) located at Gambang, Kuantan. UMP is located near to gas service station, approximately 500 m with the existing gas service station in Gambang, it is convenient way to tap the natural gas at future point to UMP. Currently, student's cafeteria using LPG bulk storage for cooking and it is not continuously supply and can disturb their production. Besides that, student also have water heater in their hostel, thus it will affect the electricity bill for every month. The scope of this project are the consumption of load demand that can accommodate for all residential college unit and student's cafeteria, network piping calculation using Cox's equation by calculation of load and determine the classification of polyethylene pipe construction, and lastly using PDMS software to draw the pipeline. The method that been used are to calculate all piping size and gas load demand by using Cox's equation according to standard such as MS930 and ASME B31.8 to make sure that the piping design is safe for the construction. As the result, the total pressure drop from the source to load consumer is below 15% which is acceptable for designing pipeline. The Medium Density polyethylene (MDPE) pipe is use for distribution line construction. Lastly, the piping sizes for MDPE pipe are 2 inches and 3 inches. As the conclusion, natural gas can reduce about 50% the utilities cost compare to electricity.

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LIST OF SYMBOLS

PE	-	Polyethylene Pipe
MDPE	-	Middle Density Polyethylene Pipe
HDPE	-	High Density Polyethylene Pipe
DS	-	District Station
ST	-	Services Station.
3D	-	3 Dimension
PDMS	-	Plant Design Management System
ASME	-	The American Society of Mechanical Engineers
KK4	-	Residential College 4
CHP	-	Combined Heat Power
P	-	Pressure
Q	-	Flow rates
L	-	Distance
S	-	Specific gravity
K	-	Coefficient
Hr	-	Hour
m	-	Meter
mm	-	Millimiter

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Pipeline is a line or series of pipes which accompany valves, pump and other to transport liquid or gases through it. Pipeline is the good transport travelling, typically in a liquid or gaseous state though in certain instances solids can be transported through pipelines. The most economically substantial pipeline is most suitable to transporting natural gas and oil. It is because the cost of transporting amount of natural gas across land is lower and having larger capacity compares using the railroad transportation or tank treller. Pipelines may be able to provide a long-term solution for transportation. Pipelines are typically constructed from plastic or steel, and built above ground level and underground at a depth of about three feet. (Pipeline-transportation-166504)

Natural gas is transported from large pipelines through smaller pipe to be used by home, industries and business. The compressor will be used to pressurize the natural gas for travel. In this study we use the polyethylene pipe of choice in distribution piping, because it most suitable for high density and underground level. Polyethylene gas pipes are also lightweight, non-corrosive, available in long distance, and easy to install by heat fusion or mechanical fittings. For these reasons, they have been proven and used since the 1960's. Normally, pipe type used for distributes oil and gas to the consumer (Osiadacz, 1987).

1.1.1 Problem Statement

Currently, laboratories at University Malaysia Pahang (UMP) utilize energy from electricity to operate the equipments per day. For example chiller and heater required respectively for operation during laboratory session. It shows that much energy will be utilized per lab session and may lead for higher operational cost as well increase the utility bills. Apart from that, others unit named Combined Heat Power (CHP) which located at FKKSA laboratory required natural gas (NG) are totally utilized and lead to insufficient supply of natural gas. Commonly, CNG is stored in bulk storage, to fill up the compressed natural gas, some procedure need to be taken into account and lead to time consumption. Due to that it may create a problem when running the CHP and other equipments.

1.1.2 Objective

The aims of this research are to design a distribution pipeline of natural gas at University Malaysia Pahang (UMP).

1.1.3 Scope of Study

1. The scope of this research to supply directly of natural gas to all equipment in FKKSA and FKASA laboratory which use natural gas.
2. To design the distribution natural gas piping system in UMP by referring at UMP map and other information.
3. The network piping calculation can be made by calculations the loads of consumption using a certain formula and also determine the classification of polyethylene pipe construction.
4. PDMS software is used to draft and draw pipelines and to choose the most suitable network drawing.

1.1.4 Rational and Significance

The significant of the research can be best described as, by using the natural gas to generate the electricity it can reduce the cost utility bill. The use of natural gas, a clean environment friendly fuel has contributed to a reduction in emissions. With increasing environment consciousness and responsibility on the part of industries in Malaysia, the benefit as becoming an important consideration in future and a step forward towards sustainable for the country.

CHAPTER 2

LITERITURE RIVIEW

2.1 Introduction of Gas System

Pipelines are seen as one of the most practical and economically effective modes for transporting dangerous and flammable substances, such as natural gas, for which road or rail transportation is often impractical. In most countries, the more that pipeline systems are expanded and natural gas consumption increases, the more their economies become dependent on the stable, continuous and safe operation of these facilities (Papadakis GA, 1997).

In gas system design, there are two categories of system which are transmission and distribution. For transmission, it only refers to natural gas where the natural gas will deliver from upstream and downstream by using transmission line. Meanwhile for distribution, it can consist of natural gas and liquefied petroleum gas. Distribution is where the fuel either natural gas or liquefied gas is distributed to consumer (Prof. Dr. Zulkefli Y, 2007) .

2.2 Properties of Natural Gas

Natural gas is considered a fossil fuel and consists of methane (CH_4). It may also contain ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}) and others. It has certain properties that enable its use for industrial or domestic purpose, such as, contains non-poisonous ingredients that when inhaled gets absorbed into our body. It is also tasteless and colorless and when it mixed with suitable amount of air and ignited, it will burn with clean blue flame. It is considered as the cleanest burning fuels and producing carbon dioxide and water as same as breathing. Natural gas is lighter than air (SG_{NG}=0.6, SG_{air}=1.0), and tends to disperse into the atmosphere (A. Roley, 1997).

Natural gas only ignites when there is an air and gas mixture and the percent of natural gas is between 5 to 15 percent. A mixture containing less or greater, natural gas would not ignite. Natural gas contains very small quantities of nitrogen (N_2), carbon dioxide (CO_2), sulfur components and water. It leads to the formation of a pure and clean burning product that is efficient to transport (Gas Malaysia Sdn Bhd).

Natural gas is the cleanest burning fossil fuel available that can leads to a cleaner environment. It can help improve the quality of the air and water. Natural gas burns to produce no harmful pollutants and is a highly reliable fuel for domestic use.

2.3 Distribution system

Main service and meters are required to distribute gas to the ultimate consumers continuously get the natural gas. The design of the new systems and addition to and renewals of existing systems is a branch of the gas engineering. The primary objective of a good design is to supply the market demand of any customer in the system with minimum cost and follow the safety practices (Cornell, 1959).

The ultimate in successful design is too able to offer adequate gas service economically to any customer within the service or franchised area. The degree to which a distribution system fails to provide such service reflects upon the engineering- design practices of the utility involved (Cornell, 1959).

For designing gas pipeline systems, Cox's equation and pole's equation are employed. Basically, for the Cox' method, the allowable pressure must be 29.4 kpag or 3000 mmH_2O or above. The pressure drop of the size pre-determined before to each appliances system shall be calculated by Cox's Formula as shown below. However, the maximum allowable pressure drop is only 15% of the supply pressure. Otherwise, it is a must to select bigger pipe size for that section in order to provide sufficient pressure or pressure drop within 15% of the supply pressure.

Cox's equation:

$$Q = K\sqrt{\frac{(P_1^2 - P_2^2)D^5}{SL}}$$

$$P_2 = \sqrt{\frac{P_1^2 - (SQ^2L)}{K^2D^5}}$$

(Assoc. Prof. Dr. Zulkefli Y, 2007)

Where:

P_1^2 = inlet pressure, kPa.abs

$P_2$2 = outlet pressure, kPa.abs

S = specific gravity of gas

Q = Flow rate, Sm^3/hr

L = Distance, meter

D = pipe diameter, mm

K = Cox's Coefficient, 1.6 x 10^{-3}

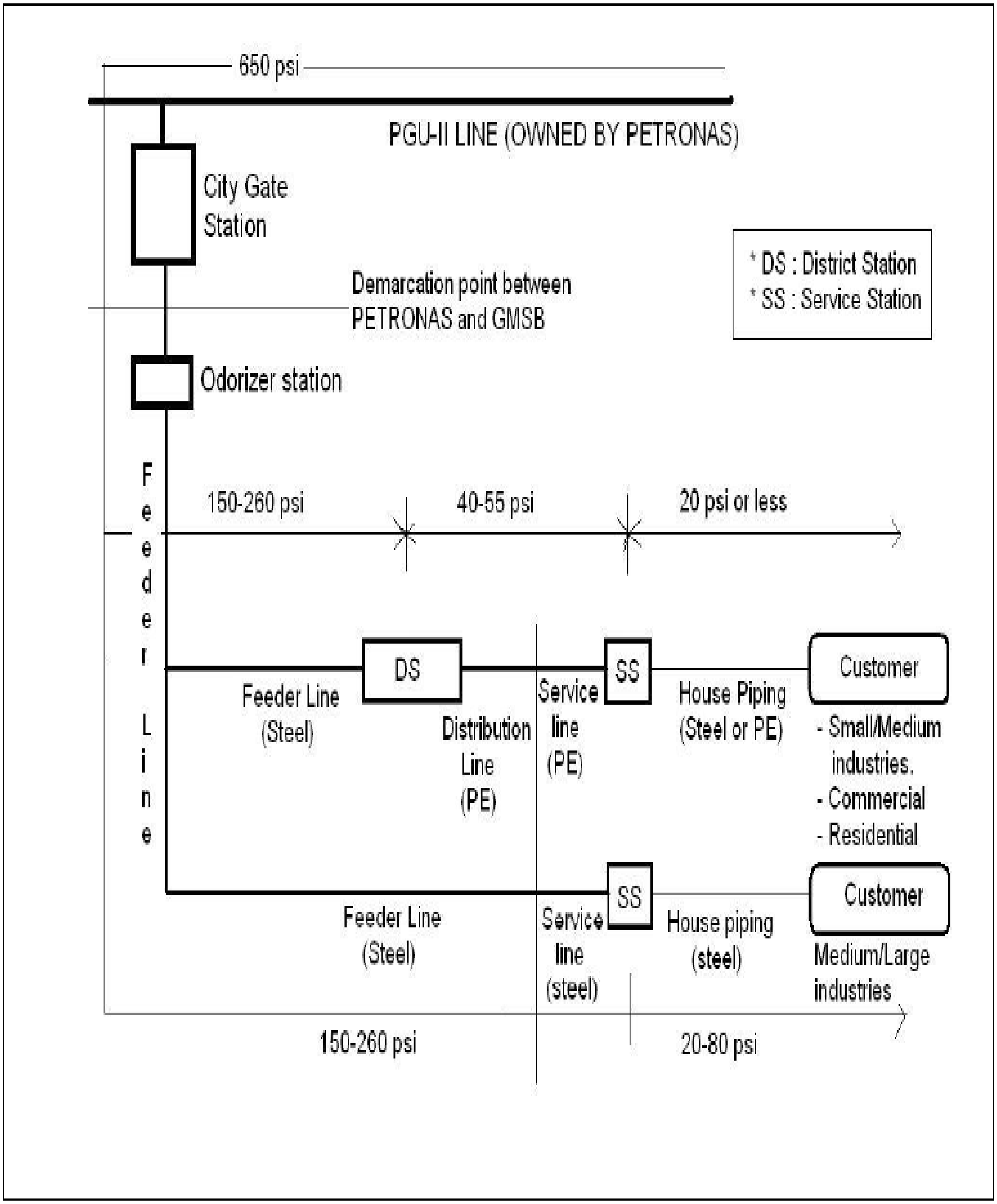

Figure 2.1: Outline of gas Malaysia natural gas supply system. (K. Yamaguchi, 1994. Outline of Gas Malaysia Natural Gas supply System. In: Gas Malaysia Sdn. Bhd. Technical Department. Malaysia.

2.3.1 Design of Pipeline

Cornell et. al. (1959) mentioned that before the pipeline project can be done/establish; there are some steps that must be done. These steps is a simple guidelines which already be done from the previous engineer/contractor that dealt with pipeline project. Steps in a pipeline project are:

1. Market survey – immediate and prospects for growth.
2. Pipe size and working pressure.
3. Pipe specifications.
4. Map of tentative route.
5. Bill of materials.
6. Total cost estimate.
7. Certificate of convenience and necessity.
8. Right of way.
9. Construction survey.
10. Construction contract.
11. Construction.
12. Testing.
13. Putting in service.

For routing process, some criteria need to consider earlier before any project will begin. It is consists of:

1. Maps

This is where the area between supply & delivery should be examined and determines either the route is possible or not to choose so that the selected route free from any constraints and other problem that will arise.

2. Survey

After the maps is determined and analyzed and the selected route has been drafted, then the visual survey will undergo to examine and to get the analysis for the selected route which is to avoid any obstacles that may face such as:

1. Congested underground plant.
2. Unstable structures.
3. Natural ground level altered.
4. Subsidence or side slip.
5. Running ground or gravel; traffic loaded routes.
6. Aggressive soil.
7. Close to cathodic protection systems.
8. Direct underneath overhead cables.
9. Internal piping, through circulating duct, chimney, gas vent, ventilation duct, enclosed staircase, elevator shaft, electricity, facility room excessive vibration area, corrosive areas, concrete slab, soil partition.

Piping systems and supports must be designed for strength and structural integrity in addition to meeting flow, pressure drop, and pump power requirements. Consideration must be given to stresses created by the following:

1. Internal pressure.
2. Static forces due to weight of the piping and the fluid.
3. Dynamic forces created by moving fluids inside the pipe.
4. External loads caused by seismic activity, temperature changes installation procedures, or other application-specific conditions.

The American Society of Mechanical Engineers (ASME), the National Fire. Association (NFPA) and others develop standards for such considerations

2.3.1 Distribution Pressures

Natural gas is usually collected in remote areas. In order for the gas to be utilized by industry and other consumers it must be transported large distances to where it is consumed. The distance natural gas can be practically transported in a pipeline is dependent on the gas pressure. Long distances require high gas pipeline pressures. Pipeline network pressure losses are caused primarily by friction losses and heat transfer to the environment. Compressor stations along the network compensate for pressure losses by boosting the pipeline pressure to more acceptable values when it becomes low. This process typically consumes about 3% to 5% of the total gas transported in order to power the compressors.

Typical pipeline pressures range from 50 to 100 bar for distances over 100 km, 20 to 50 bar for distances over 20 km, below 10 bar for a distribution grid such as an urban area, and down to as low as 10 mbar at the consumer. This sequence of decreasing pressures occurs in stages and is accomplished using regulator stations (Herrán-González, 2008).

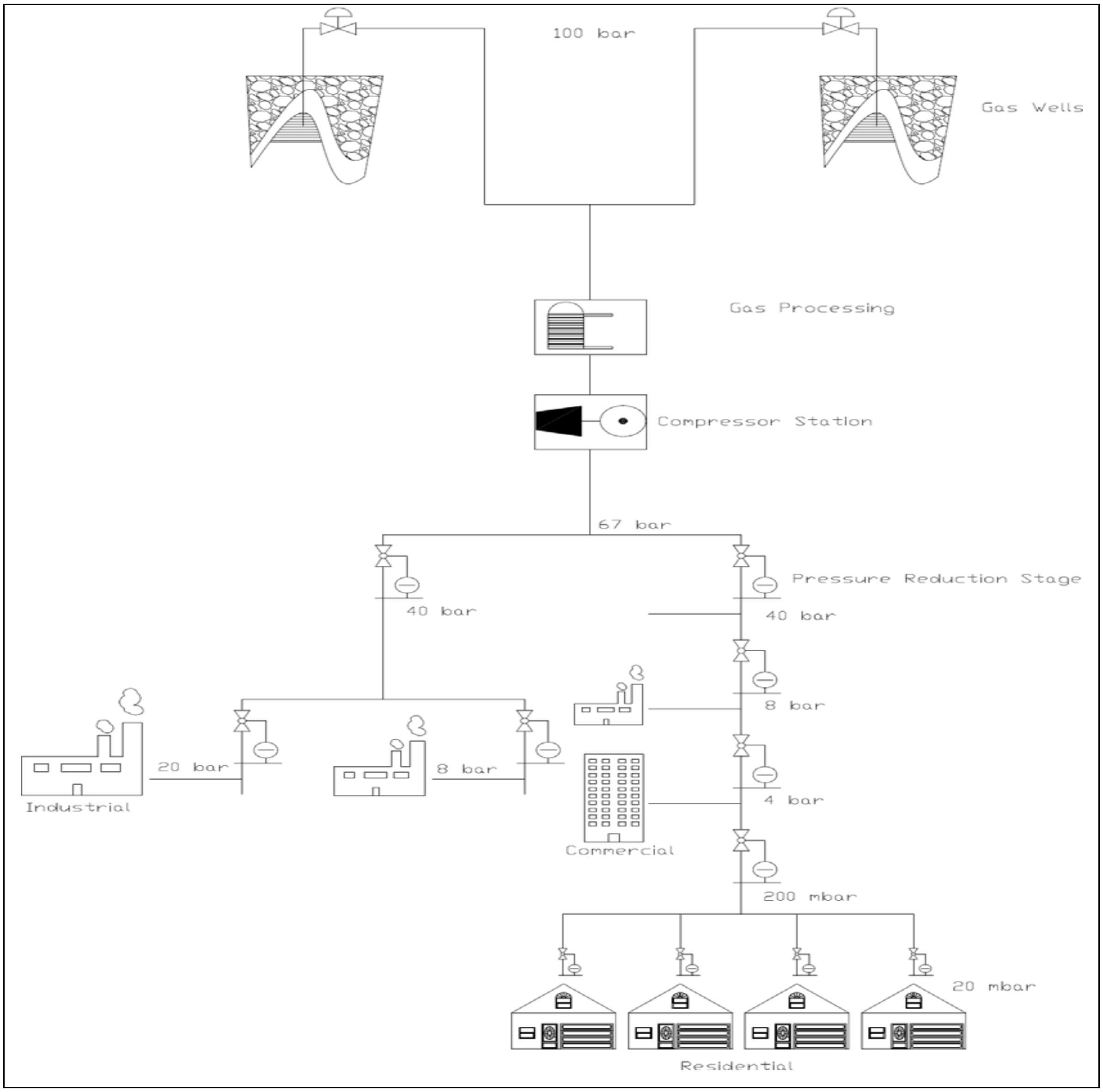

Figure 2.2 Layout of Natural Gas Distribution Network

2.4 Standards and Codes

In this project, the existing standards and code such as ASME B31.8, MS 930 and Act 501 are used as references. In Malaysia, it is commonly referred to Malaysia Standard as this standard has been used widely in gas distribution in Malaysia. For further references, other standard will be used if suitable such ASME B31.8.

2.5 Types of Pipe

Commonly the polyethylene pipe are used widely in transmission and distribution system that is because this portable, easy handling inert to the soil resistance to corrosion. Polyethylene pipe have 3 types which polyethylene pipe (PE), middle density polyethylene pipe (MDPE) and high density polyethylene pipe (HDPE). The design pressure of polyethylene pipe is differently each other which the MDPE pipe is around 60 psig and for HDPE pipe is around 100 psig.

Piping made from polyethylene pipe is a cost effective solution for a broad range of piping problem in industrial, residential, agricultural applications and others. Polyethylene is portable for natural gas transportation for transmission and distribution line. Middle density polyethylene pipe (MDPE) and High density polyethylene pipe (HDPE) can carry for long distance of natural gas and no reaction occur during transportation. Polyethylene is portable because easy to joining, easy to coil, strong or extremely tough and very durable (Prof. Dr. Zulkefli Y, 2007).

This pipe is portable because the cost for maintenance is lower compare with others pipe and easy to handling during make the maintenance. HDPE has excellent corrosion resistance and is virtually inert. It does not need expensive maintenance or cathodic protection. It offers better overall resistance to corrosive acids, bases and salts than most piping materials. In addition, polyethylene is unaffected by bacteria, fungi and the most aggressive naturally occurring soils. It has good resistance to many organic substances, such as solvents and fuels.

Polyethylene pipe is normally joined by heat fusion. Butt, socket, sidewall fusion and electro fusion create a joint that is as strong as the pipe itself, and is virtually leak free. This unique joining method produces significant cost reductions compared to other materials. The polyethylene also can make excellent flow characteristics, it is because polyethylene is smoother than steel, cast iron, ductile iron, or concrete, and a smaller PE pipe can carry an equivalent volumetric flow rate at the same pressure. It has less drag and a lower tendency for turbulence at high flow. Its superior chemical resistance and non-stick surface combine eliminate scaling and pitting and preserve the excellent hydraulic characteristics throughout the pipe service life.

Polyethylene pipe is produced in straight lengths or in coils. Made from materials about one-eighth the density of steel, it is lightweight and does not require the use of heavy lifting equipment for installation. It reduces the need for fittings, is excellent in shifting soils and performs well in earthquake-prone areas. MDPE and HDPE resist the effects of freezing and allow bending without the need for an excessive number of fittings. Since MDPE and HDPE is not a brittle material, it can be installed with bends over uneven terrain easily in continuous lengths without additional welds or couplings (Prof. Dr. Zulkefli Y, 2007).

Figure 2.3: Middle density Polyethylene pipe (MDPE)

Figure 2.4: High density Polyethylene pipe (HDPE)

Figure 2.3 and 2.4 show the types of polyethylene pipe which middle density polyethylene pipe (MDPE) and high density polyethylene pipe (HDPE). This pipe become reduces the installation cost and lower life cycle costs.

Lower life cycle costs

1. Corrosion resistance. Does not rust, rot or corrode.
2. Leak tight. Heat-fused joints create a homogenous, monolithic system. The fusion joint is stronger than the pipe.
3. Maintains optimum flow rates. Does not tuberculation, has a high resistance to scale or biological build-up.
4. Excellent water hammer characteristics. Designed to withstand surge events.
5. High strain allowance. Virtually eliminates breakage due to freezing pipes.
6. Additional cost savings are achieved by lower instance of repairs.
7. No infiltration or infiltration, potable water losses and groundwater nuisance costs encountered in traditional piping systems are eliminated.

Reduces the installation costs

1. Material of choice for trenchless technology. Used in directional boring, plowing, river crossings, pipe bursting and slip lining.
2. Fewer fittings due to pipe flexibility. Allowable bending radius of 20 to 25 times outside diameter of pipe.
3. Lighter equipment required for handling and installation than with metallic materials.
4. Eliminates the need for thrust blocking. Heat fused joints are fully restrained.
5. Light weight and longer lengths allow for significant savings in labor and equipment.

2.6 Plant Design Management System (PDMS) Software

AVEVA PDMS is a complex program with different application that enables discipline designer to create a 3D model of a plant design. It is a customizable, multi-user and multi-discipline, engineer controlled design software package for engineering, design and construction projects in offshore and onshore oil & gas industry, chemical and process plants, mining, pharmaceutical & food industry, power generation and paper industries. PDMS is a multi-discipline 3D modeling system that allows stimulating a detailed, full size model of all significant parts of a process plant. It also allows seeing a full colour shaded representation of the plant model as design progresses, adding an unprecedented level of realism to design project (AVEVA Solutions, 2009).

Figure 2.5: Simulation of Piping System using PDMS software

CHAPTER 3

METHODOLOGY

3.1 Solving Techniques

The main objective of this project is to design the distribution line of natural gas to UMP lab and residential college unit (KK4). First, collect all important data such as load consumption, formula that been used and flow of this project. From this data, the flow of progress will go well and if there any problem while making this project, the problem will be review back and discussed.

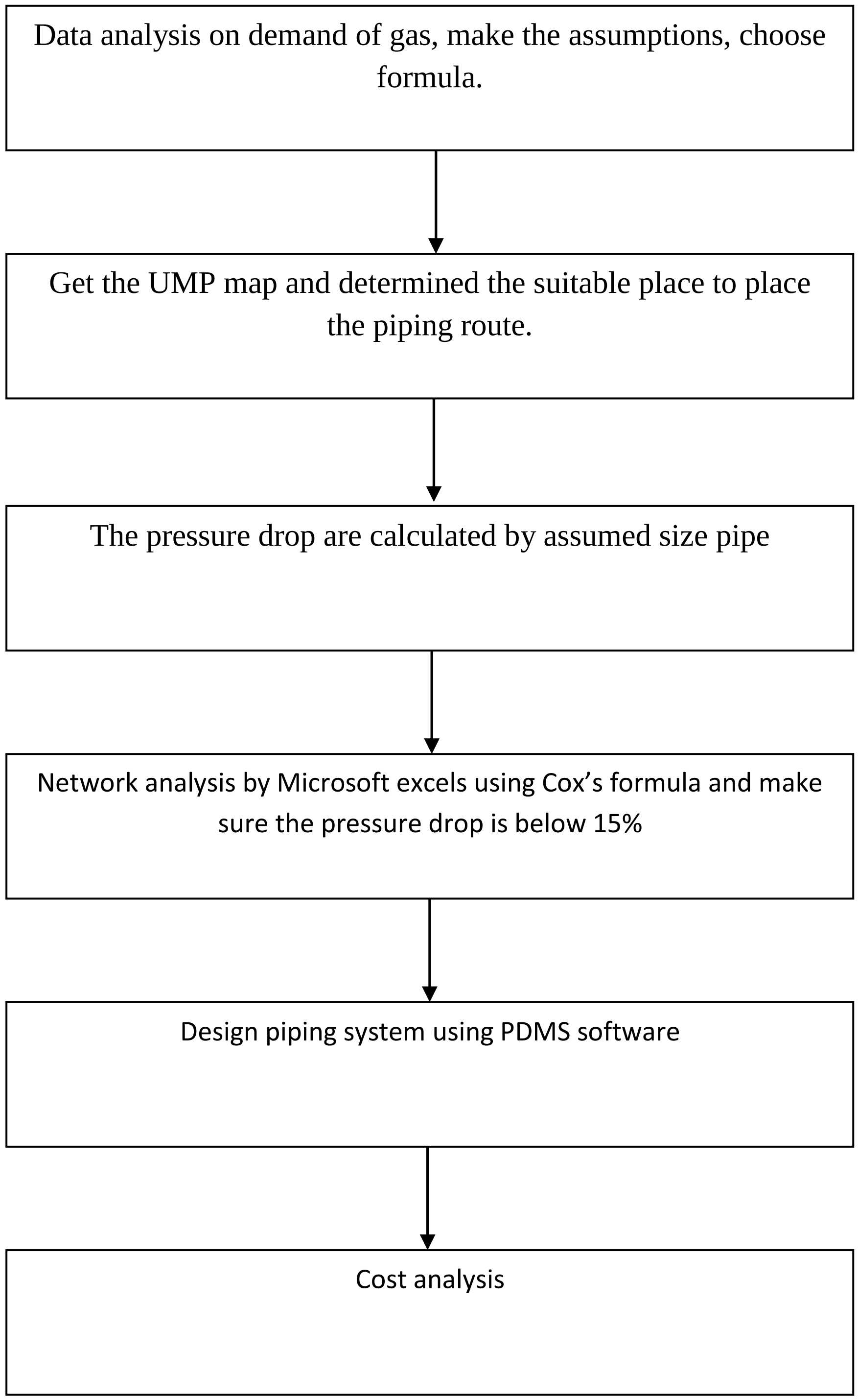

Figure 3.1: flow chart of overall piping design

3.1.1 Study load consumption

Surveys are making to know the all equipment in lab UMP is use the gas. In this case, the loads of demand are considered. The total load demand for the UMP lab is 2418900 Btu/hr which include storage water heater, combined heat power (CHP), gas burner and chiller.

While for the residential college unit (KK4) and Cafeteria KK4 the consumption of load demand is 379346.8257 Btu/hr which include gas burner and water heater.

3.1.2 Network analysis

The Cox's formula is used to calculate the pressure drop that need to transmit to the customers, this formula only used for distribution piping system which the operating pressure not exceed 420 kpa (60 psig). The EXCELL also is used to get more accurate calculation or analysis. In this case, the suitable pressure is below 15 %.

3.1.3 Design piping system using PDMS

Plan Design Management System (PDMS) also help to solve piping design more accurate than normal method, but PDMS used for designing pipe in 3D. It is very helpful to the engineers to know the exactly the diameter, length or thickness of the pipe and the total equipment for the piping installation. Therefore, the calculation of cost installation of piping can easier to calculated after draw by using PDMS because the result from PDMS show the all types of equipment are used.

3.1.4 Cost analysis

In this case the material are considered, which the best material are choose to use to make the piping system. Therefore, the comparison are making between use the electricity and natural gas to run the equipment in the lab. Natural gas is better than electricity because the natural gas is cheaper compare with other fuel. So, the natural gas is most suitable to use in the UMP lab.

CHAPTER 4

4.0 RESULT AND DISCUSSION

4.1 Result

After used the manual calculation and by excel the pressure drop have been calculated and the calculation have been made are correct and precise in term of measurement and pipe sizing. From the calculation the pipe size are been choose by using standard from MS930 and maximum gas demand. The costing are also considered to choose the available pipe size because when using the small pipe the cost is low compare use the big pipe, but the pressure drop must be consider after to choose the available size pipe.

There are two types of piping layout to choose which the first type is looping and the second one is branch. These layouts are showed together as a comparison for each other. The pipe route selection for this project is selected according to the safety, accessibility, and costing factor. After some discussion, the final pipe route selection is using the branch type without looping. It is because, the UMP is small campus and there is no need to have a loop in this system as the gas pressure is higher and adequate to supply to consumer. Then, the looping system also it will increase the cost of construction and material are used.

To choose the size pipe, the percent of pressure drop must be below 15 %. For this situation, the different pipe size are been calculated by using Cox's formula to determined the pressure drop by different pipe size. The total load demands are used as main basis to make the calculation.

Cox's equation:

$$Q = K\sqrt{\frac{(P_1^2 - P_2^2)D^5}{SL}}$$

$$P_2 = \sqrt{\frac{P_1^2 - (SQ^2L)}{K^2D^5}}$$

Where:

P_1^2 = inlet pressure, kPa.abs

$P_2$2 = outlet pressure, kPa.abs

S = specific gravity of gas

Q = Flow rate, Sm^3/hr

L = Distance, meter

D = pipe diameter, mm

K = Cox's Coefficient, 1.6×10^{-3}

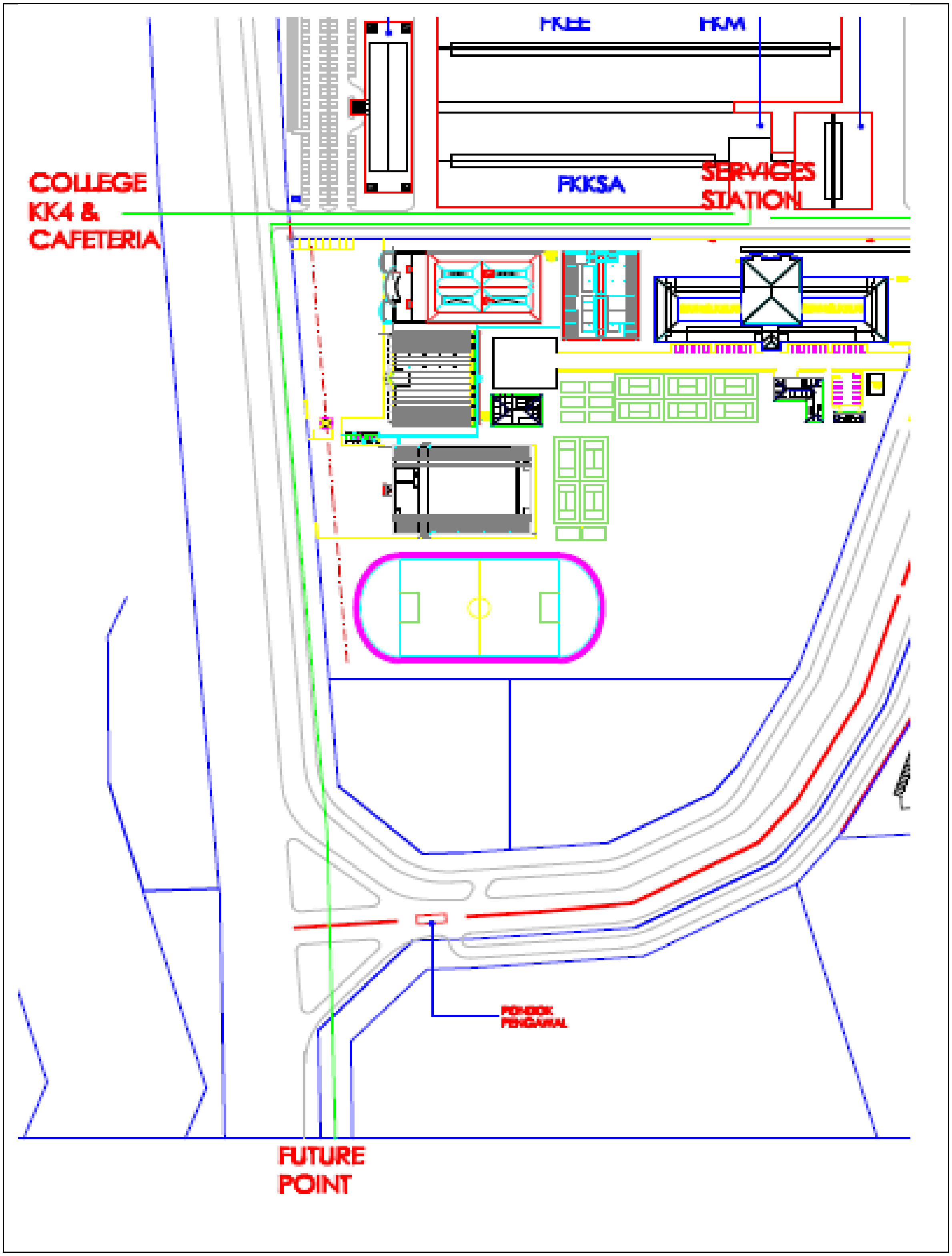

Figure 4.1: Show the drawing for design piping distribution at UMP Gambang

4.1.1 Future Point as Supply Source

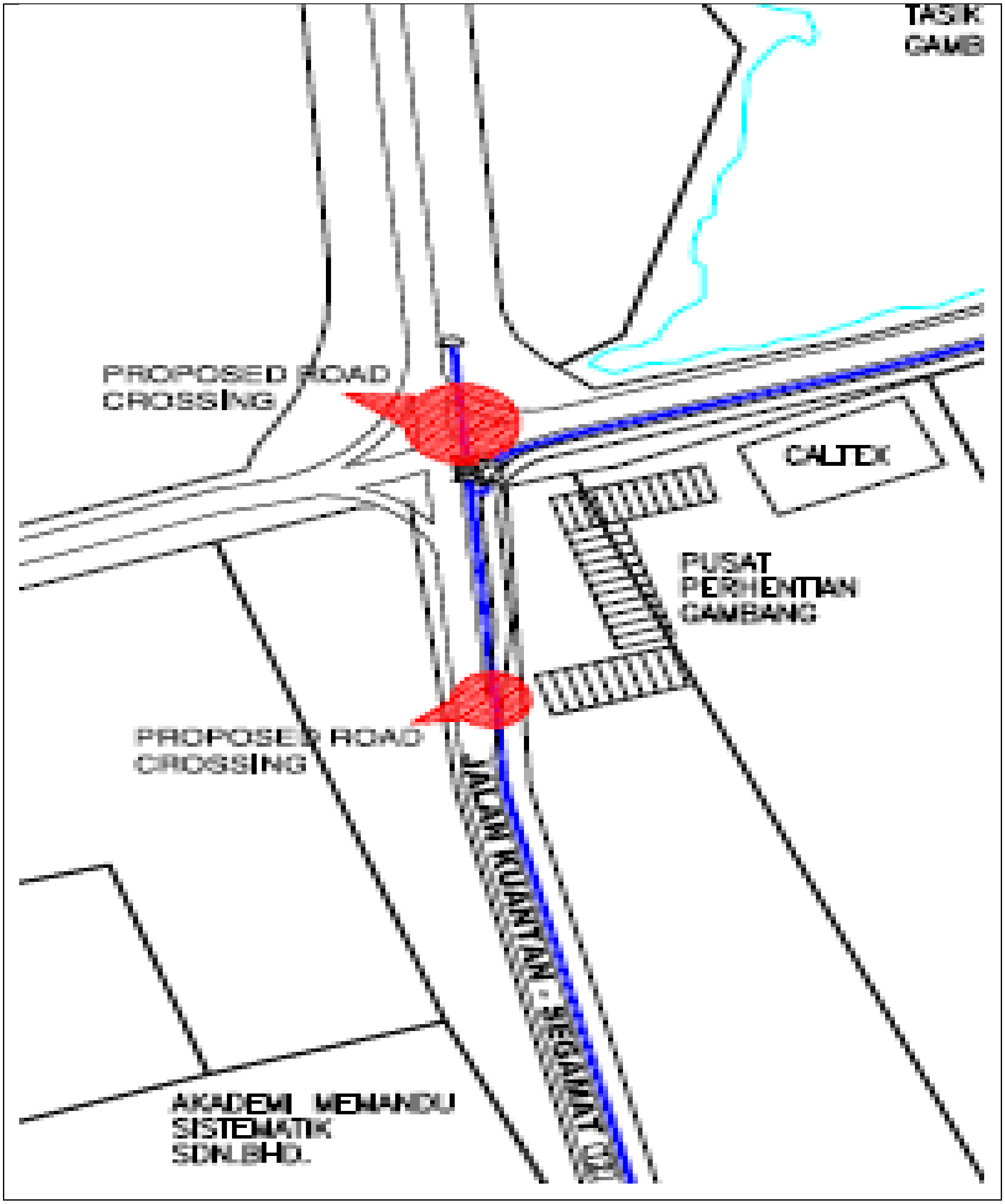

Figure 4.2: Show the source of the natural gas was tagged

Figure 4.2 show the source of the natural gas tag from future point at Jalan Gambang-Kuala Lumpur nearest Lake of Gambang. These future points are prepared by Gas Malaysia Sdn Bhd (GMSB) to propose for future development. Therefore, project at UMP Gambang directly tag from this future point. The pressure at this future point is 20 psi respectively and capable to supply at UMP Gambang (UMP lab, residential college unit, cafeteria and all equipment are used of natural gas).

4.1.2 Route of Pipe Distribution System

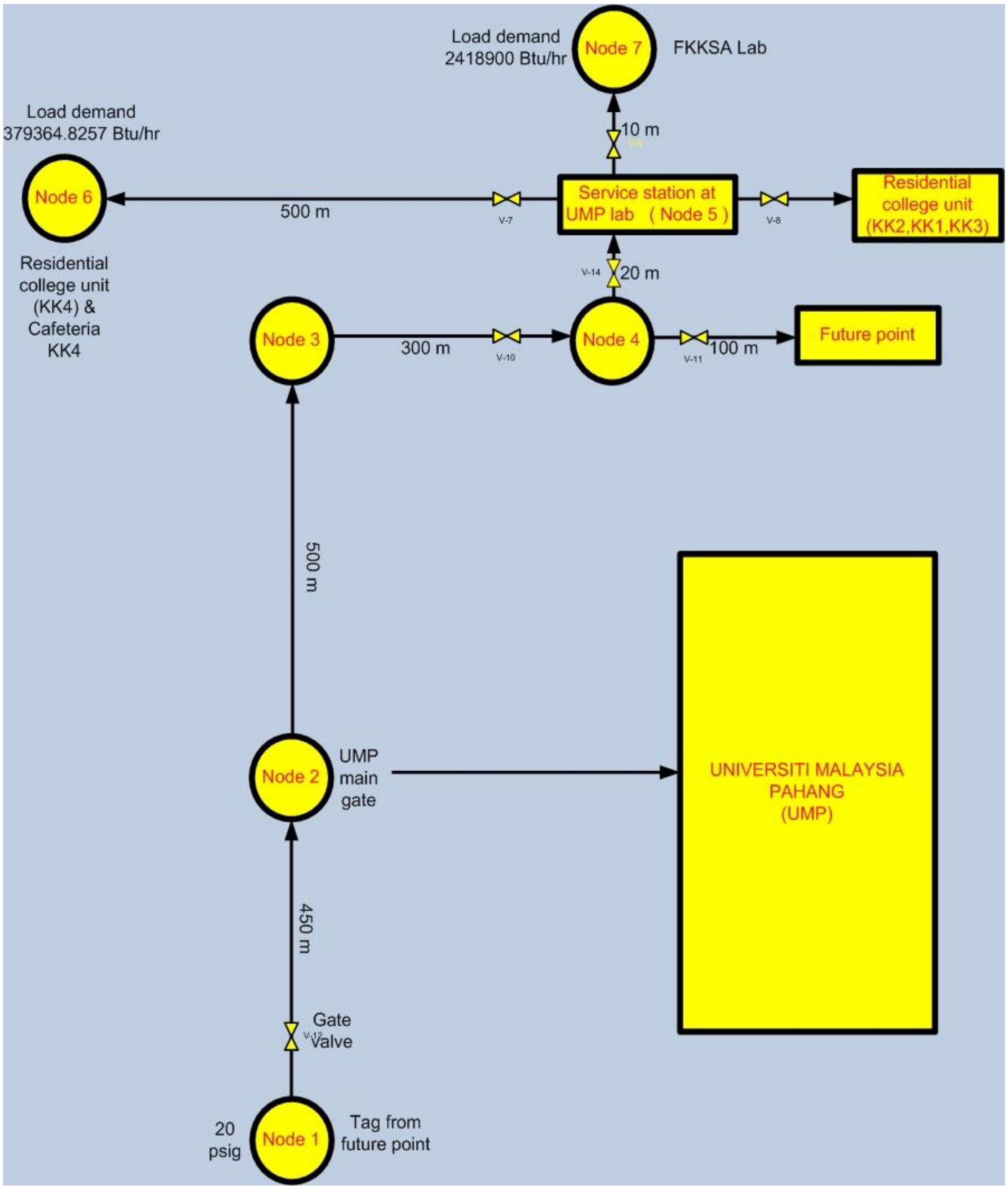

Figure 4.3: Show the natural gas distribution line

Table 4.1: Result of data input of piping layout

Node	Comsumpstion (Sm3/hr)	Length (m)	Pipe size (mm)	wall thickness (mm)	diameter (mm)	inlet pressure P1 (kpa abs)	outlet pressure P2 (kpa abs)	presure drop	% pressure drop
1~2	214.382	450	80	5.49	69.02	137.9	127.4460708	10.45392923	7.58080437
2~3	214.382	500	80	5.49	69.02	127.446	114.7186199	12.72738008	9.98648846
3~4	214.382	300	80	5.49	69.02	114.719	106.3540139	8.364986136	7.291718143
1~2	214.382	450	100	6.02	87.96	137.9	134.8749229	3.025077087	2.193674465
2~3	214.382	500	100	6.02	87.96	134.875	131.4321705	3.442829521	2.552607615
3~4	214.382	300	100	6.02	87.96	131.432	129.3223125	2.109687497	1.605155135
1~2	214.382	450	125	6.55	111.9	137.9	136.9991694	0.900830602	0.653249167
2~3	214.382	500	125	6.55	111.9	136.999	135.9910774	1.00792261	0.735715305
3~4	214.382	300	125	6.55	111.9	135.991	135.3826442	0.608355772	0.447350025
5~6	10.432	500	50	3.91	42.18	34.475	33.21009745	1.264902546	3.669042918
5~6	10.432	500	80	5.49	69.02	34.475	34.36899113	0.106008866	0.307494897
5~6	10.432	500	100	6.02	87.96	34.475	34.44349924	0.031500764	0.091372774

In table 4.1 which shows the result of data input of piping layout by using Microsoft excel by consider the Cox's formula as equation. There are 10 types in this table which load or consumption in Sm3/hr, length in meter, pipe size in millimeter, wall thickness in millimeter, diameter in meter and pressure in kpa. For this case, the four types of size pipe are been consider which the first pipe is 50 mm (2 in), 80 mm (3 in), 100 mm (4 in) and the last one is 125 mm (5 in). By assume the different size pipe the pressure drop are calculated and therefore, the suitable size pipe will be choose can be consider by using the percent of pressure drop.

4.1.3 Plant Design Management System (PDMS)

PDMS is interesting for designing of piping system, PDMS can make easily for user to rapidly build a fully detailed model of all piping systems, based on component catalogues and engineering specifications. From this model, Piping General Arrangement drawings, isometric drawings and bill of quantity are produced. All drawings, including Piping General Arrangements and isometrics, have associative dimensions and intelligent annotations, and can therefore be updated automatically in line with design changes.

Before start the PDMS the coordinate every equipment must be set up (x, y, z) and the second one is direction, which must be consider the north, east, west and south. This is important for PDMS before start the drawing, it is because to easily to make the design of piping and easily to setting when have the correction and addition of equipment.

Then, the fitting of equipment and pipe must be choosing follow the specification of standard. It is because when make the drawing using the PDMS the specification every equipment and types of pipe must be correct, if not the error is occur during make the drawing. The last one the diameter size pipe, elbow, valve, flange, tee and others equipment must be set up before start the drawing because to make become easily to make the joining every equipment or pipe.

PDMS 1

This drawing show the piping design from future point at Jalan Gambang-Kuala Lumpur which node 1 until at services station at UMP lab which node 4. The length of pipe from future point until node 2 is 450 m, from node 2 until node 3 is 500 m and for node 3 until node 4 is 300 m. The pressure drop from node 1 until node 4 is 106.354 kpa and the percent of pressure drop is 7.292%.

3D view

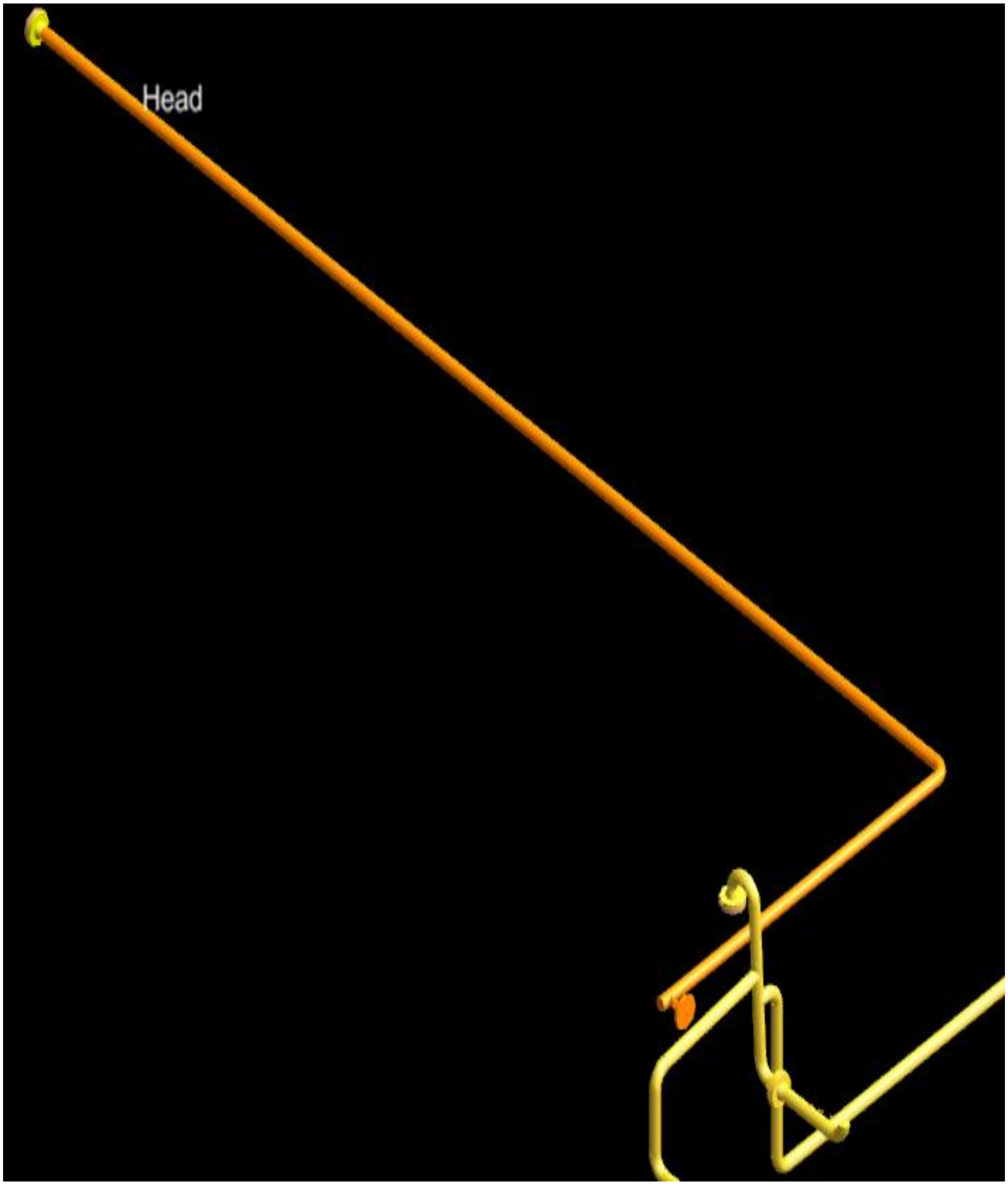

Figure 4.4: Show the 3D view from node 1 until node 4

2D View (isometric view)

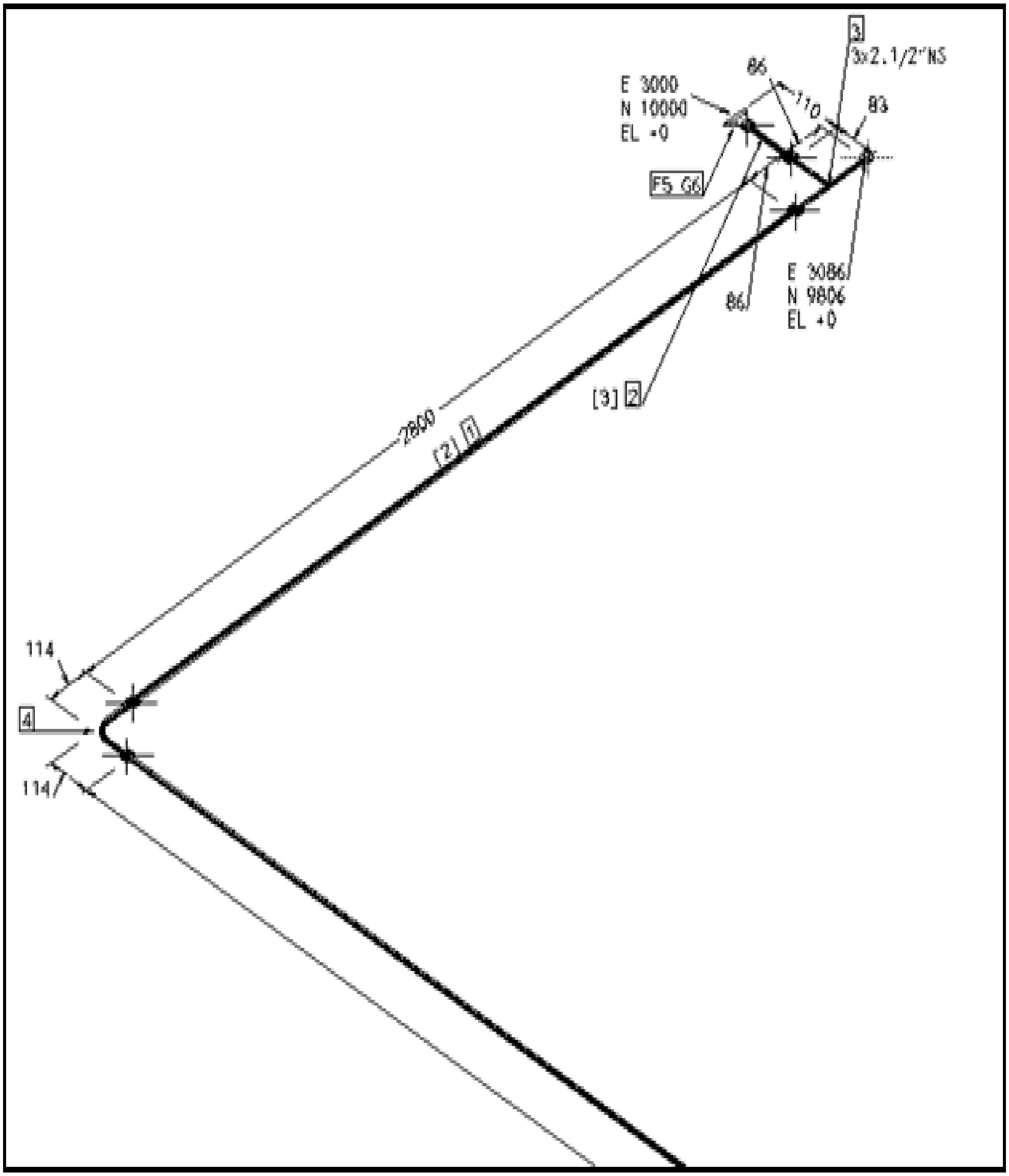

Figure 4.5: Show the 2D view from node 1 until node 4

PDMS 2

For this drawing show the piping design from node 4 at services station at UMP lab to residential unit college KK4 and cafeteria KK4 which node 5. The length of pipe from node 5 until node 6 is 500 m. In this drawing also show the quantity of equipment must be used to make installation. Therefore the installation can make easily by refer this information. The pressure drop from node 1 until node 4 is 34.369 kpa and the percent of pressure drop is 0.307 %.

3D view

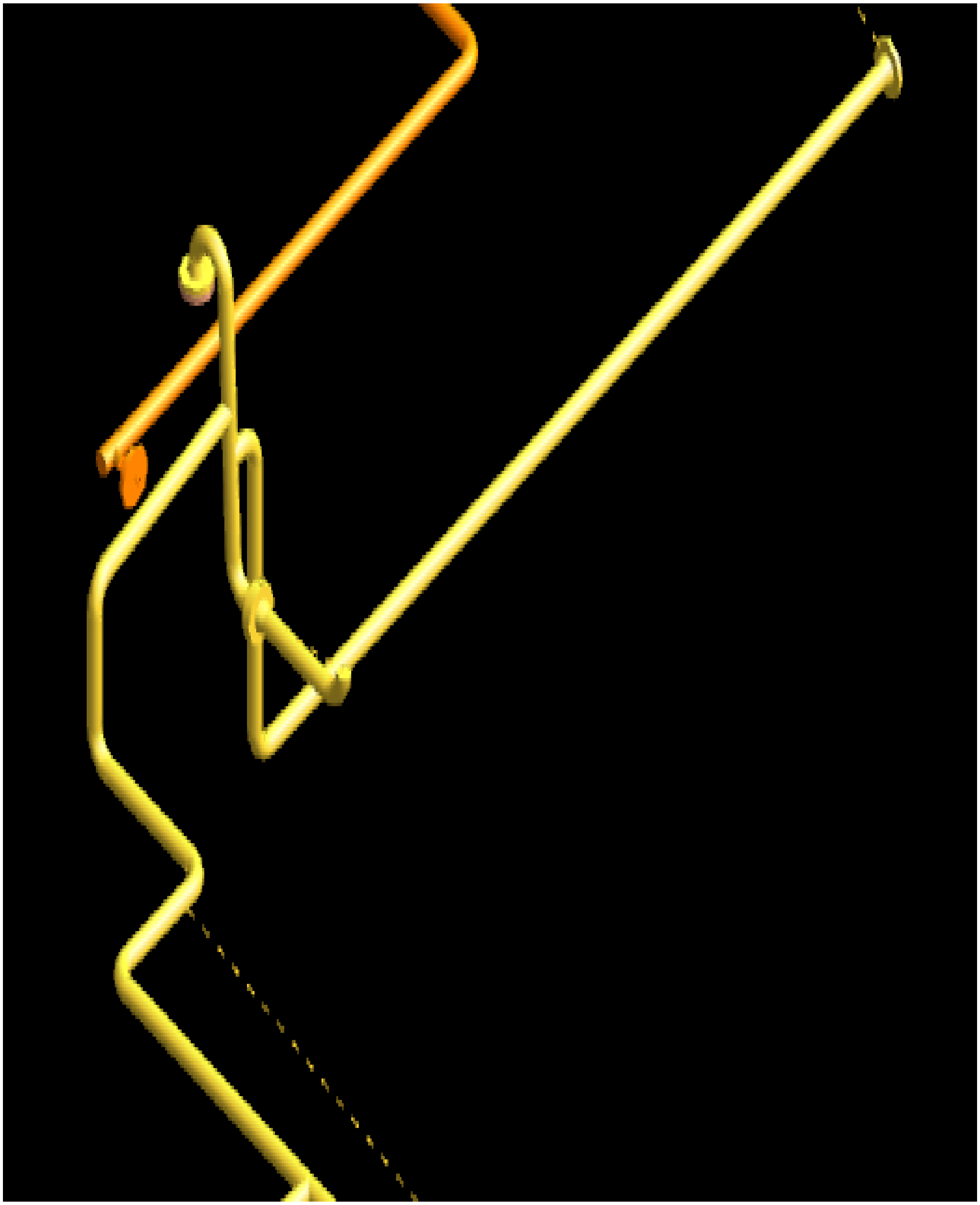

Figure 4.6: Show the 3D view from node 5 until node 6

2D view (isometric view)

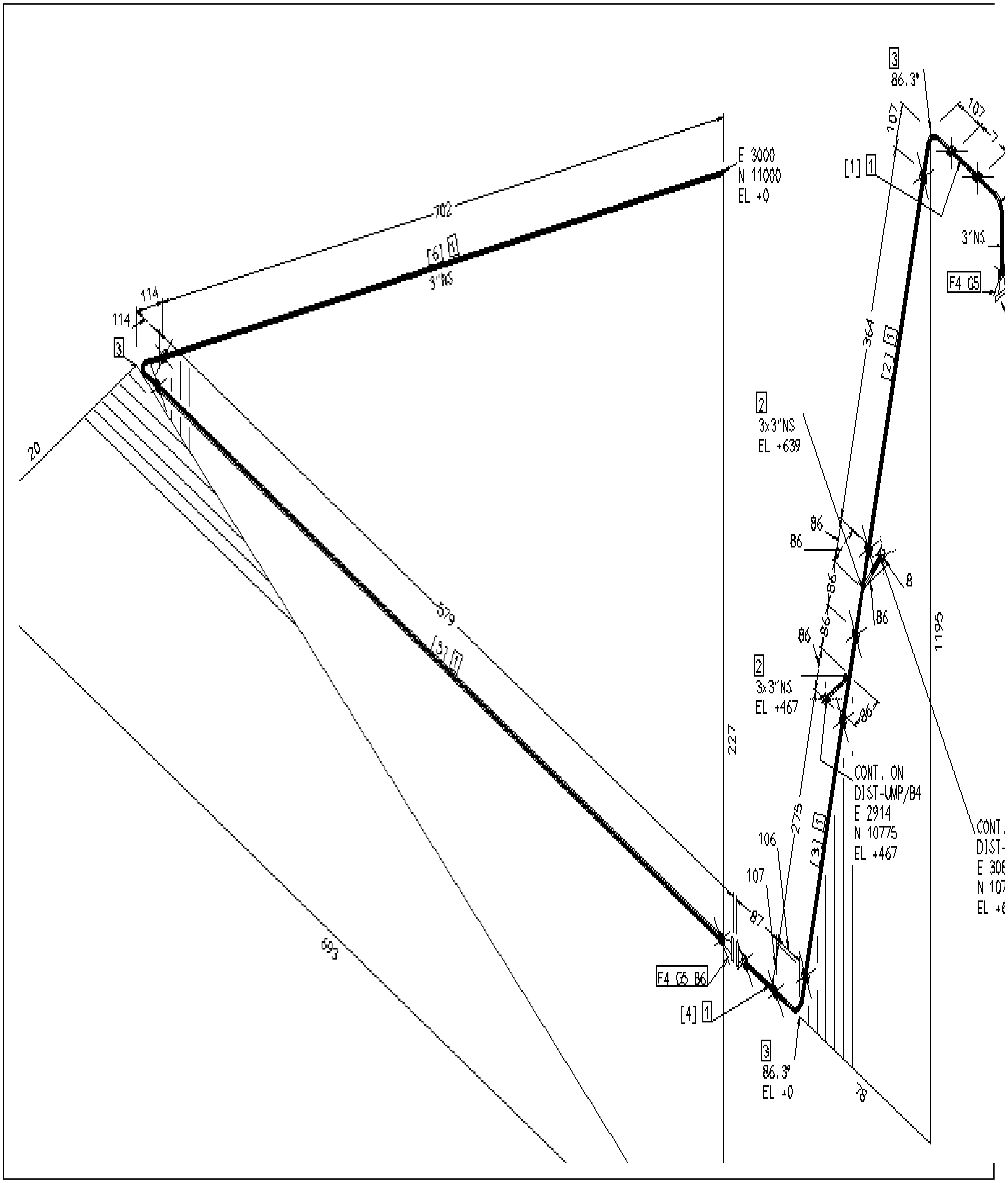

Figure 4.7: Show the 2D view from node 5 until node 6

4.2 Discussion

The result of piping network by using Microsoft excel which use the Cox's formula the pressure of gas at the end point is 5 psig and the piping size fitting are 80 mm (3 in), 100 mm (4 in), 125 mm (5 in) and 50 mm (2 in) of diameter. After make the discussion the 3 in of size pipe are been choosed as a size pipe for the installation for this project. It is because the 3 in pipe most available to make the pressure drop is lower and will be decrease the cost of construction and material.

For the 3 inches diameter pipe which the pressure drop from source to node 2 is 106.354 kpa (15.424 psi) which the inlet pressure at node 1 is 137.9 kpa (20 psi). Then from node 2 until node 3 the pressure drop is 114.7 kpa (16.64 psi) and from node 3 until node is 106.35 kpa (15.42 psi). While at node 5 to node 6 the pressure drop is 34.37 kpa (4.98 psi).

Then, for the 4 inches diameter pipe the pressure drop is 134.87 kpa (19.56 psi) from node 1 until node 2. From node 2 to until node 3 is 131.43 kpa (19.06 psi) and then from node 3 to node 4 is 129.32 kpa (18.76 psi) and the last one is from node 5 to node 6 is 34.44 kpa (4.99psi).

And the others pipe is 2 inches and 5 inches. The 5 inches only calculated from node 1 until node 4 it is because the pressure drop is low and not fitting for decrease the pressure. While the 2 inches only fitting at the end point from node 5 to node 6, it is because the it cannot support the high pressure at the starting inlet pressure which is higher than with design pressure of pipe.

The all pipe are been calculated actually is available, other aspect is must be consider the costing of current price for every size pipe. Costing is most important to make distribution piping after consider the safety and follow the standard. The current price showed the price for small pipes is cheaper compare with bigger pipe. For this case also must be consider the maximum gas demand for every equipment, which when the load demand of equipment is higher automatically must be using the bigger pipe. It is because to decrease the pressure drop, but it also must be choose 3 size pipes or upper to make the comparison about pressure drop and costing. Which the most fitting of size pipe is 3 inches which it will be reduce the cost of construction and material selection. It also can make become easily to decrease the pressure before arrive at end point. The percent of pressure drops also not exceed 15 % follow the standard from MS930.

4.2.1 Material Selection

In this project will be use the piping made from polyethylene pipe which is cost effective solution for distribution line. It has been tested and proven effective for above ground, surface, buried, slip lined, floating, and sub-surface marine applications. Polyethylene is strong, extremely tough and very durable.

For Selection of piping material, it will be use the Middle Density polyethylene pipe (MDPE) which will be used in the overall installation of distribution line. Which, it most suitable to used for underground distribution pipelines, connected to all residential college unit KK4, cafeteria and UMP lab. By follow the standard from ASME B31.8 Gas Transmission and Distribution Piping System, the maximum operating pressure for MDPE pipe is 100 psig. Therefore that is not become problem or issues as in this project which is referring the MS930 the maximum operating pressure is not exceed 5 psig.

The PE pipe have more advantages which it become reduced the installation cost and lower life cycle cost. PE pipe is light weight and longer length allow for significant savings in construction and equipment. Lighter equipment required for handling and installation than with metallic materials. It fewer is fitting due to pipe flexibility which allowable bending radius of 20 to 25 times outside diameter of pipe. Leak tight heat fused joints create a homogenous, monolithic system; the fusion joint is stronger than the pipe. The PE pipe is free from corrosion occur and become save the cost of cycle. Then, it also excellent water hammer characteristic and design to withstand surge events.

The reason why MDPE pipe is been selected because there was free from corrosion, low investment cost for construction, take a short time to make the installation and directly decrease the labor cost. It will be easy to make the joining and easy to coiled. The MDPE pipe is widely used in gas industry and available with the operating pressure is low.

4.2.2 Comparison Cost Effective by using Natural Gas and Electricity

The average electricity tariff is 31.31 cent/kWh and natural gas tariff is RM 18.22/MMBTU according by Suruhanjaya Tenaga on 2009. The cost bill can be reduced by approximately 50% by using natural gas as source of energy. From the table 4.2 and table 4.3 the cost of utilities can be reducing when using the natural gas as the source energy in the future development. By this project UMP can save the money for every month when use the natural gas.

In the future if UMP can totally use the natural gas as source of energy the budget for payment electricity bill for every month can use for other project and can saving for other future development.

FKKSA Lab

	Natural gas	Electric
	Combine Heat Power (CHP)	
Energy consumption	2037750 BTU/hr	
Usage	1 hour	
Monthly cost (RM)	1113.8	
	Gas Burner	
Energy consumption	9000 BTU/hr	2500 Watt/hr
Usage	1 hour	1 hour
Monthly cost (RM)	4.92	37.57
Total cost (RM)	4.92	37.57

Table 4.2: Cost bill for natural gas and electricity

Residential College Unit KK4 & Cafeteria KK4

	Natural gas	**Electric**
	Cooker (4 burner)	
Energy consumption	9000 BTU/h	2500 Watt/h
Usage	1 hour	1 hour
Monthly cost (RM)	4.92	23.50
	Water heater	
Energy consumption	50000 BTU/h	4000 Watt/h
Usage	1 hour	1 hour
Monthly cost (RM)	27.33	37.57
Total cost (RM)	**32.25**	**61.07**

Table 4.3: Cost bill for natural gas and electricity

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

` As a conclusion the design of piping for UMP Lab and residential college unit is easily to install. The objective already achieves which is to design a gas distribution piping systems that using natural gas as source energy. All the pressure drop and pipe size are been determined by using Cox's formula which the gas will be flow continuously and there is no problem with lacking of service or no supply of gas. It is because, the calculation was correct in term of gas of load demand effect the pipe size and pressure drop. From the calculation that has been made, this system also is compatible with the natural gas usage. When these projects are constructed, the University Malaysia Pahang can reduce its monthly cost of operation of bill electricity especially for the chiller, CHP and other electric consumption machines. The consequences of this project will make the University Malaysia Pahang become famous in Malaysia since it the only university that has its own gas center and fully utilize with the gas distribution system and as a center for research and development.

5.2 Recommendation

1. To make feasibility study on consumption of electricity in UMP and alternative way how to minimize the monthly cost of electricity.

2. Need to find the current data of plant layout area UMP and Gambang for future development.

3. Need to use the GAPIS software to make the analysis to get more precise of requirement.

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APPENDICES

A. For Combined Heat Power (FKKSA Lab)

1. Application Input Rating (Fuel Consumption)

   = 1950000 Btu/hr

2. Total gas demand, QT = Flow rate x no of usage

   QT = 1950000 Btu/hr x 1
   = 1950000 Btu/hr

   Increasing 10 % gas utilization for future

   QT = 1950000 Btu/hr + 195000
   = 2145000 Btu/hr

3. Effective gas demand, QE

   QE = QT x C_F (Building Coincidence Factor)

   $$C_F = \frac{0.95}{n^{0.3}}$$

   $$C_F = \frac{0.95}{1^{0.3}}$$

   C_F = 0.95

4. QE = 2145000 Btu/hr x 0.95
   = 2037750 Btu/hr

B. For Gas Burner (FKKSA Lab)

1. Application Input Rating (Fuel Consumption)

   = 200000 Btu/hr

2. Total gas demand, QT = Flow rate x no of usage

   QT = 200000 Btu/hr x 1
   = 200000 Btu/hr

   Increasing 10 % gas utilization for future

   QT = 200000 Btu/hr + 20000
   = 220000 Btu/hr

3. Effective gas demand, QE

   QE = QT x C_F (Building Coincidence Factor)

   $$C_F = \frac{0.95}{n^{0.3}}$$

   $$C_F = \frac{0.95}{1^{0.3}}$$

   C_F = 0.95

4. QE = 220000 Btu/hr x 0.95
   = 209000 Btu/hr

C. For Storage Water Heater (FKKSA Lab)

1. Application Input Rating (Fuel Consumption)

   = 90000 Btu/hr

2. Total gas demand, QT = Flow rate x no of usage

   QT = 90000 Btu/hr x 1
   = 90000 Btu/hr

   Increasing 10 % gas utilization for future

   QT = 90000 Btu/hr + 9000
   = 99000 Btu/hr

3. Effective gas demand, QE

   QE = QT x C_F (Building Coincidence Factor)

   $$C_F = \frac{0.95}{n^{0.3}}$$

   $$C_F = \frac{0.95}{1^{0.3}}$$

   C_F = 0.95

4. QE = 99000 Btu/hr x 0.95
   = 99000 Btu/hr

Total Load Demand FKKSA Lab

QE = 209000 Btu/hr + 99000 Btu/hr + 2037750 Btu/hr

= 2345750 Btu/hr

D. For Residential College KK4 (WATER HEATER)

5. Application Input Rating (Fuel Consumption)

   = 30000 Btu/hr

6. Total gas demand, QT = Flow rate x no of usage

   QT = 30000 Btu/hr x 30
   = 900000 Btu/hr

   Increasing 10 % gas utilization for future

   QT = 900000 Btu/hr + 90000
   = 990000 Btu/hr

7. Effective gas demand, QE

   QE = QT x C_F (Building Coincidence Factor)

   $$C_F = \frac{0.95}{n^{0.3}}$$

   $$C_F = \frac{0.95}{30^{0.3}}$$

   C_F = 0.342442

8. QE = 990000Btu/hr x 0.34244216
   = 339017.7393 Btu/hr

E. For CAFETERIA KK4 (SMALL GAS BURNER)

1. Application Input Rating (Fuel Consumption)

   = 130000 Btu/hr

2. Total gas demand, QT = Flow rate x no of usage

   QT = 130000 Btu/hr x 8
   = 1040000 Btu/hr

   Increasing 10 % gas utilization for future

   QT = 1040000 Btu/hr + 104000
   = 1144000 Btu/hr

3. Effective gas demand, QE

   QE = QT x C_F (Building Coincidence Factor)

   $$C_F = \frac{0.95}{n^{0.3}}$$

   $$C_F = \frac{0.95}{8^{0.3}}$$

   C_F = 0.509092

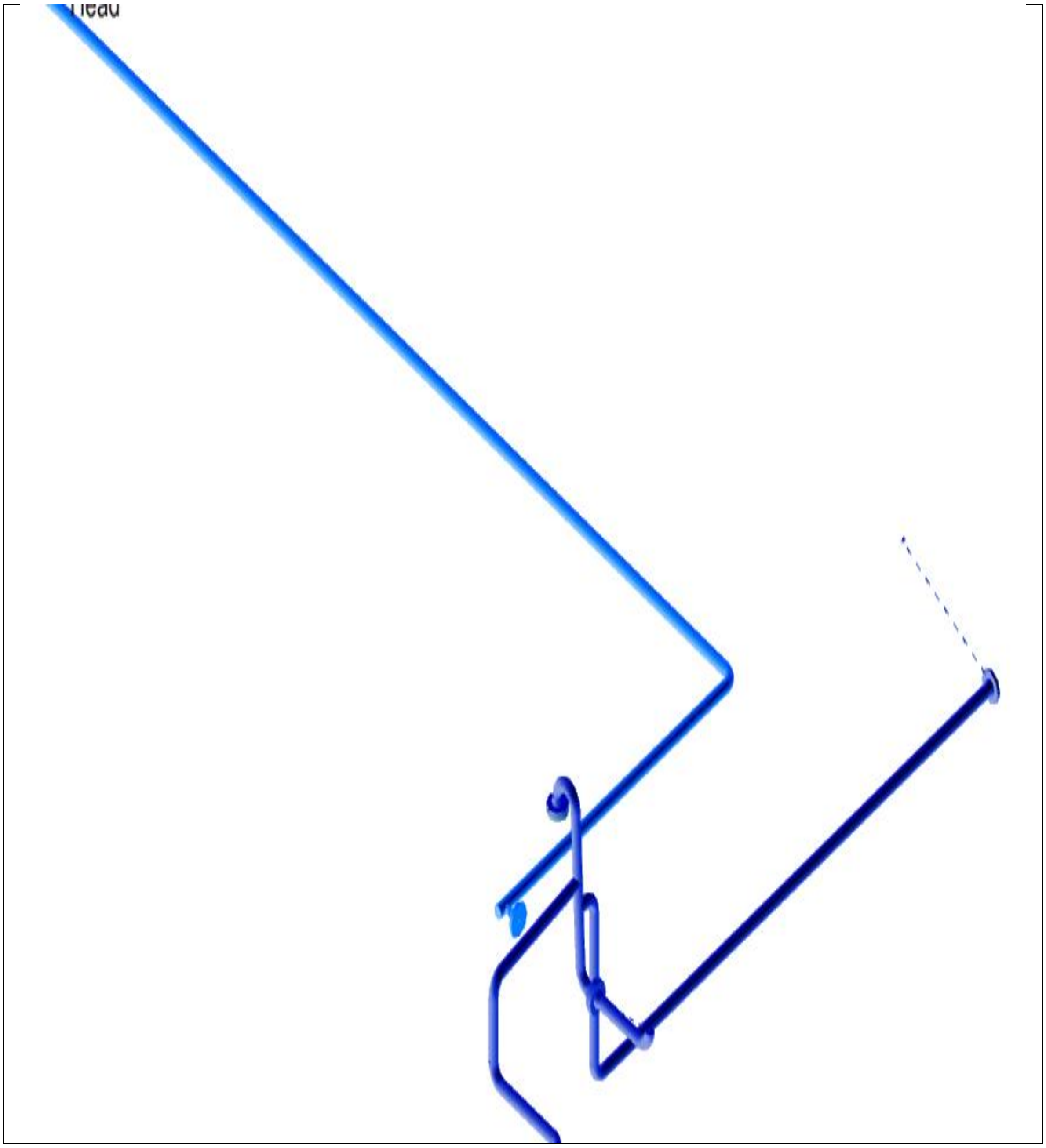
4. QE = 1144000 Btu/hr x 0.509092
   = 582401.248 Btu/hr

Total Load Demand KK4

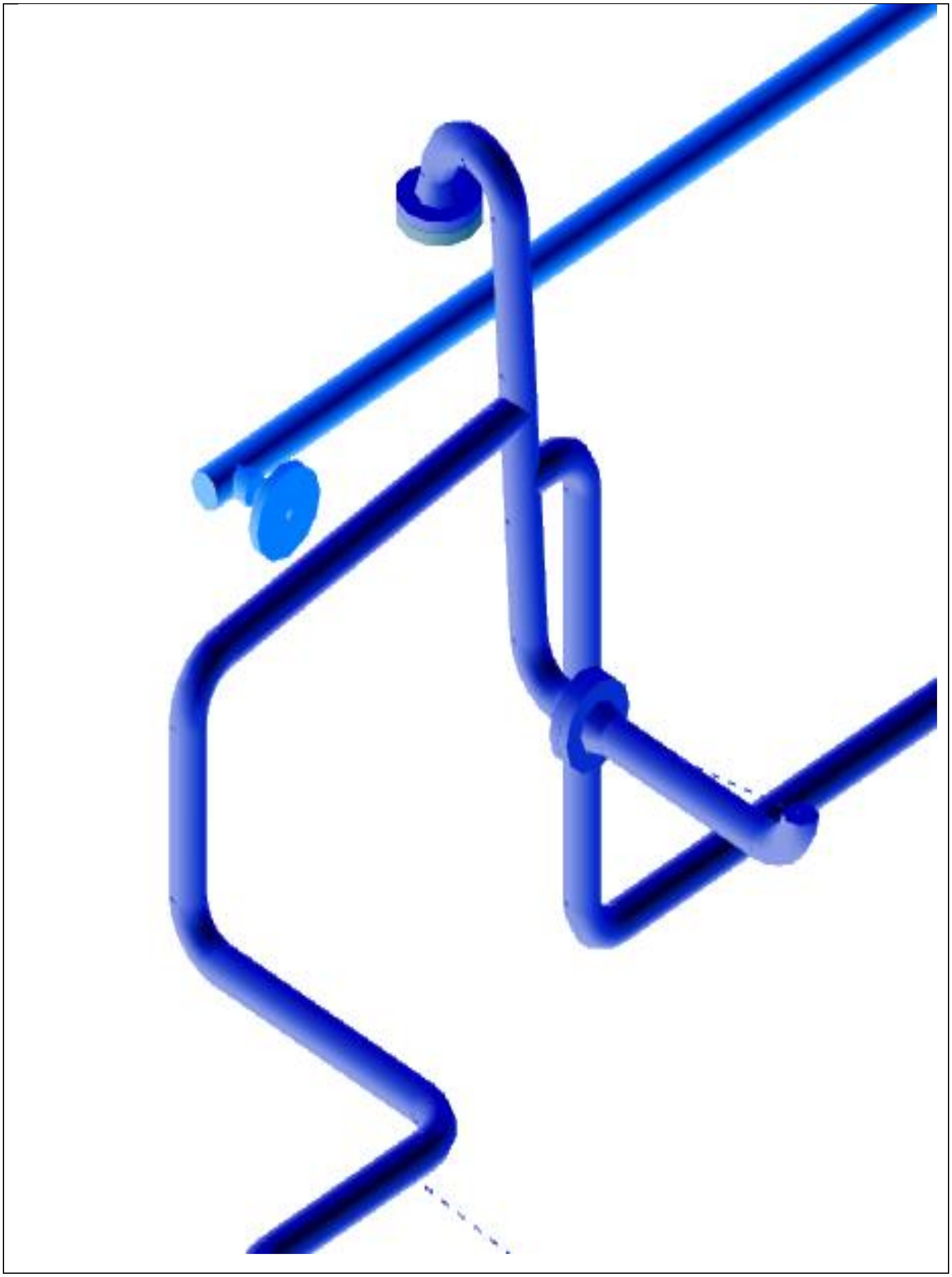
QE = 339017.7393 Btu/hr + 582401.248 Btu/hr

= 921418.9873 Btu/hr

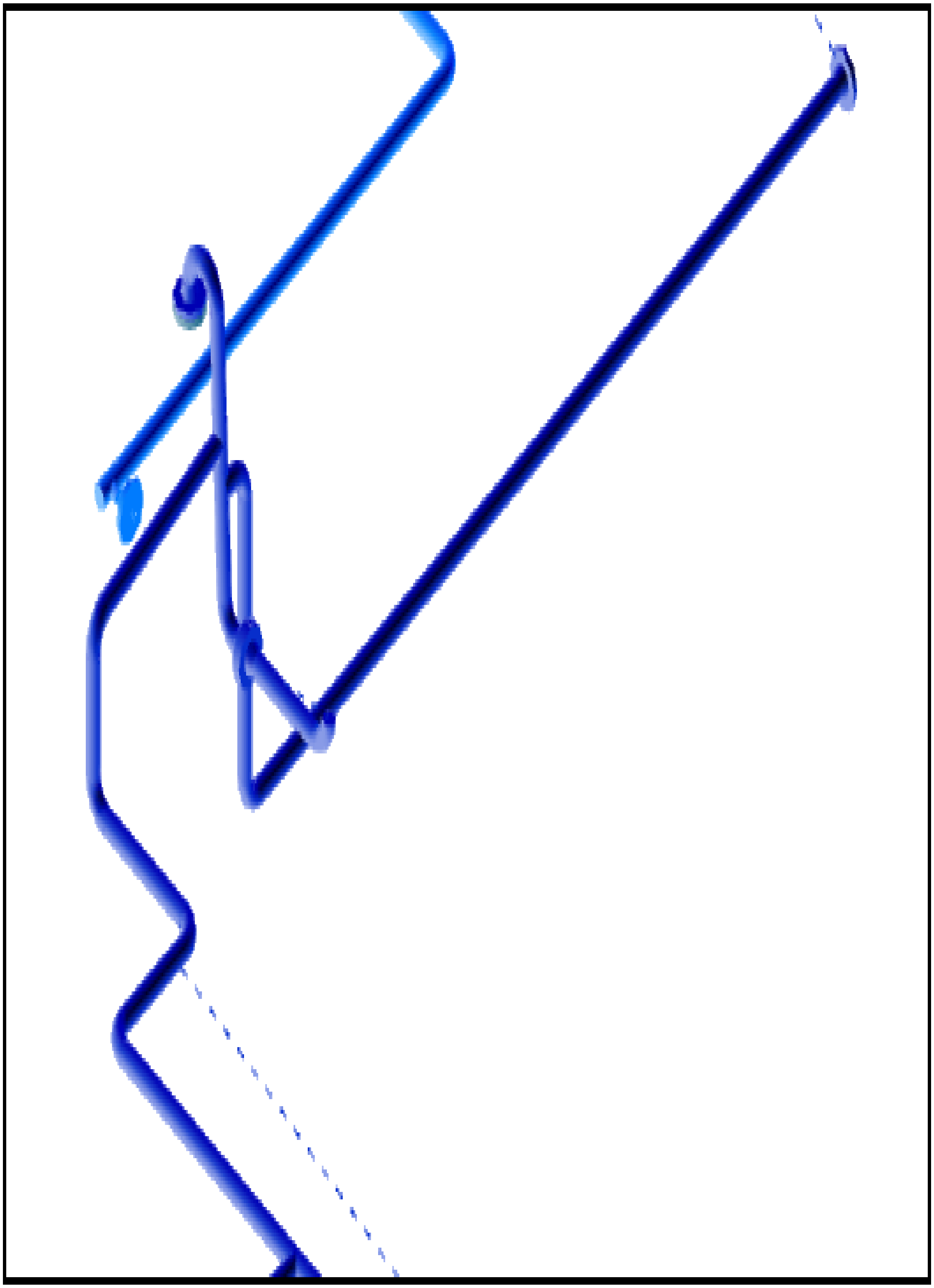
F. PDMS (3D view)



Picture 1

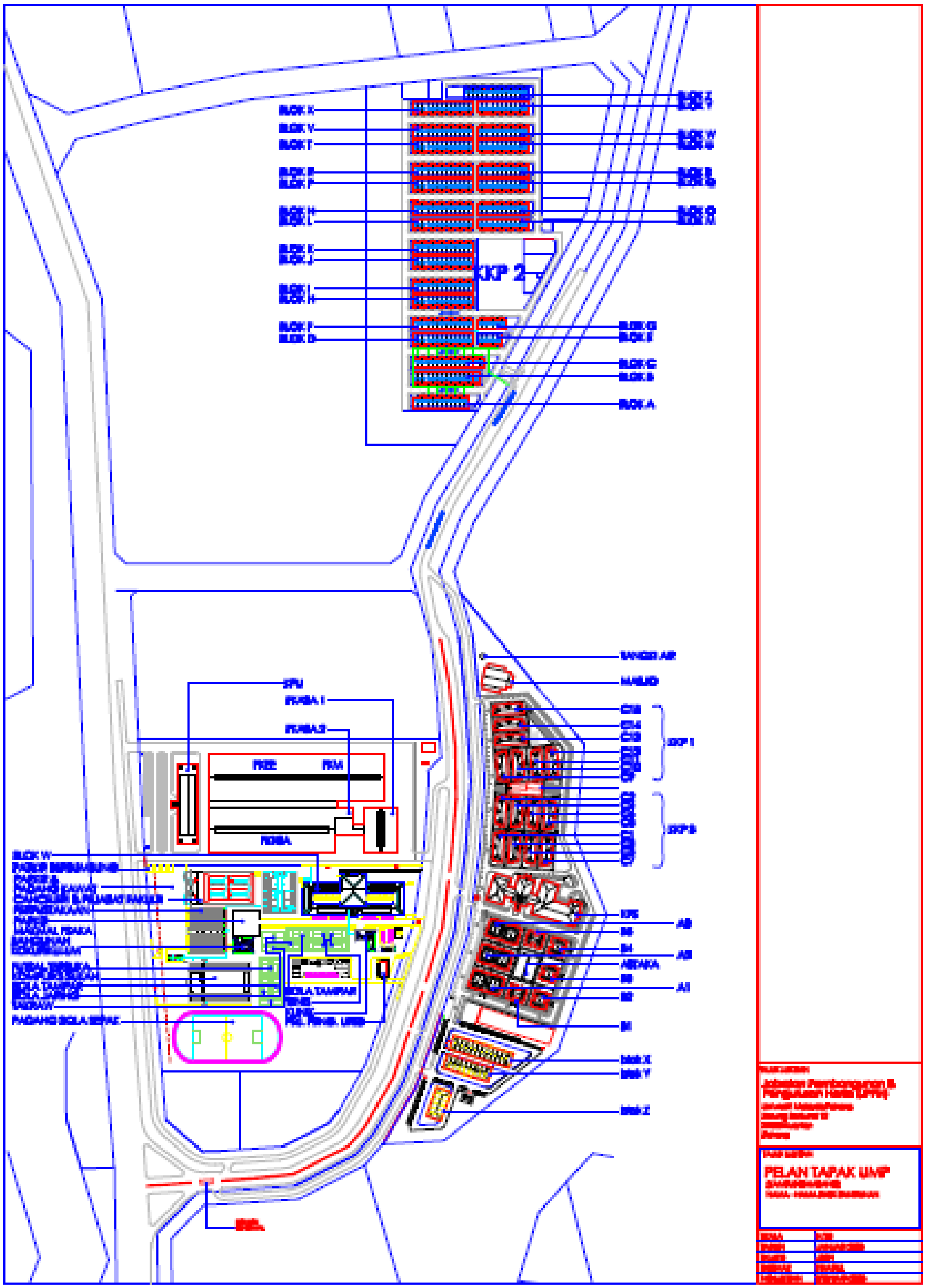


Picture 2

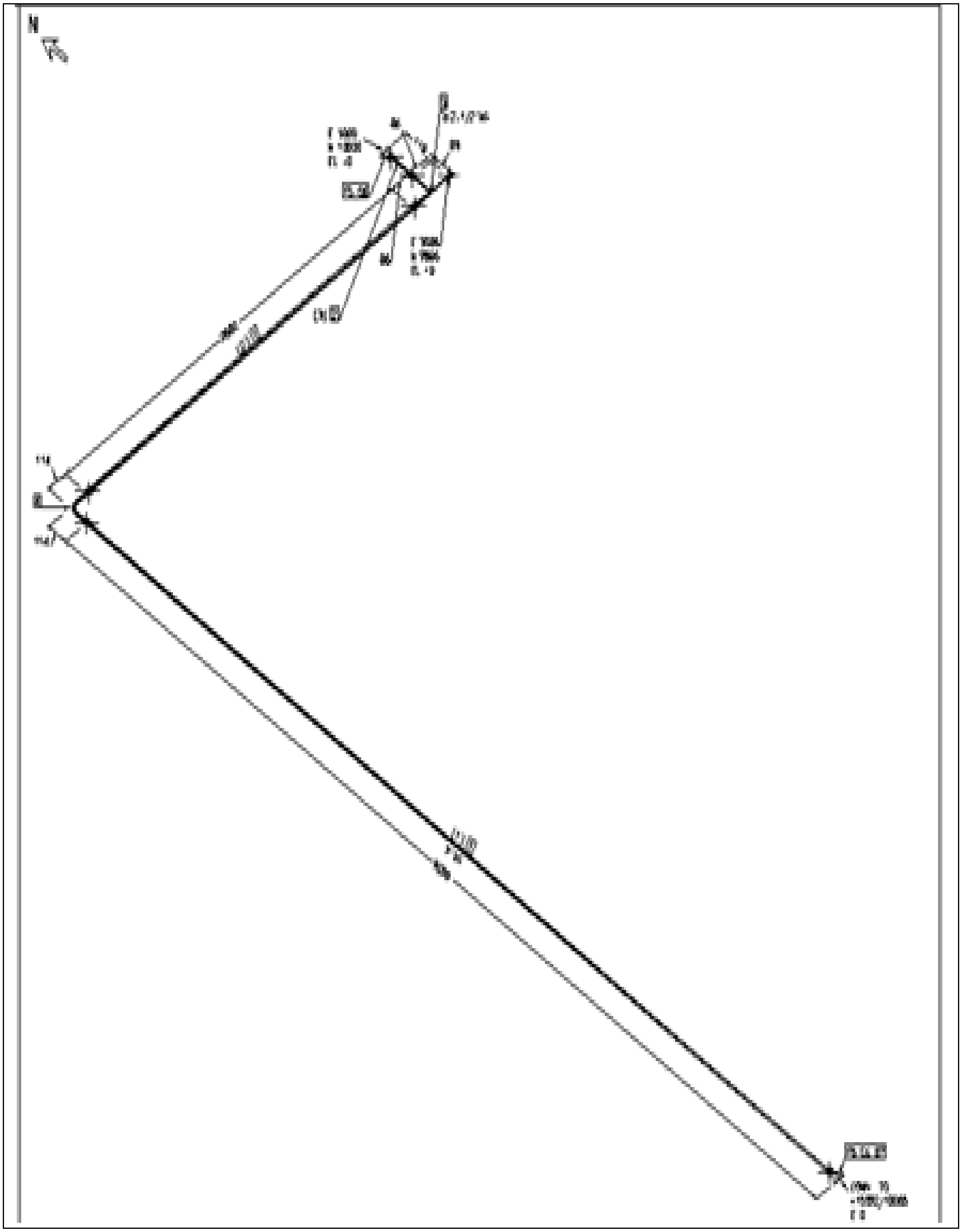


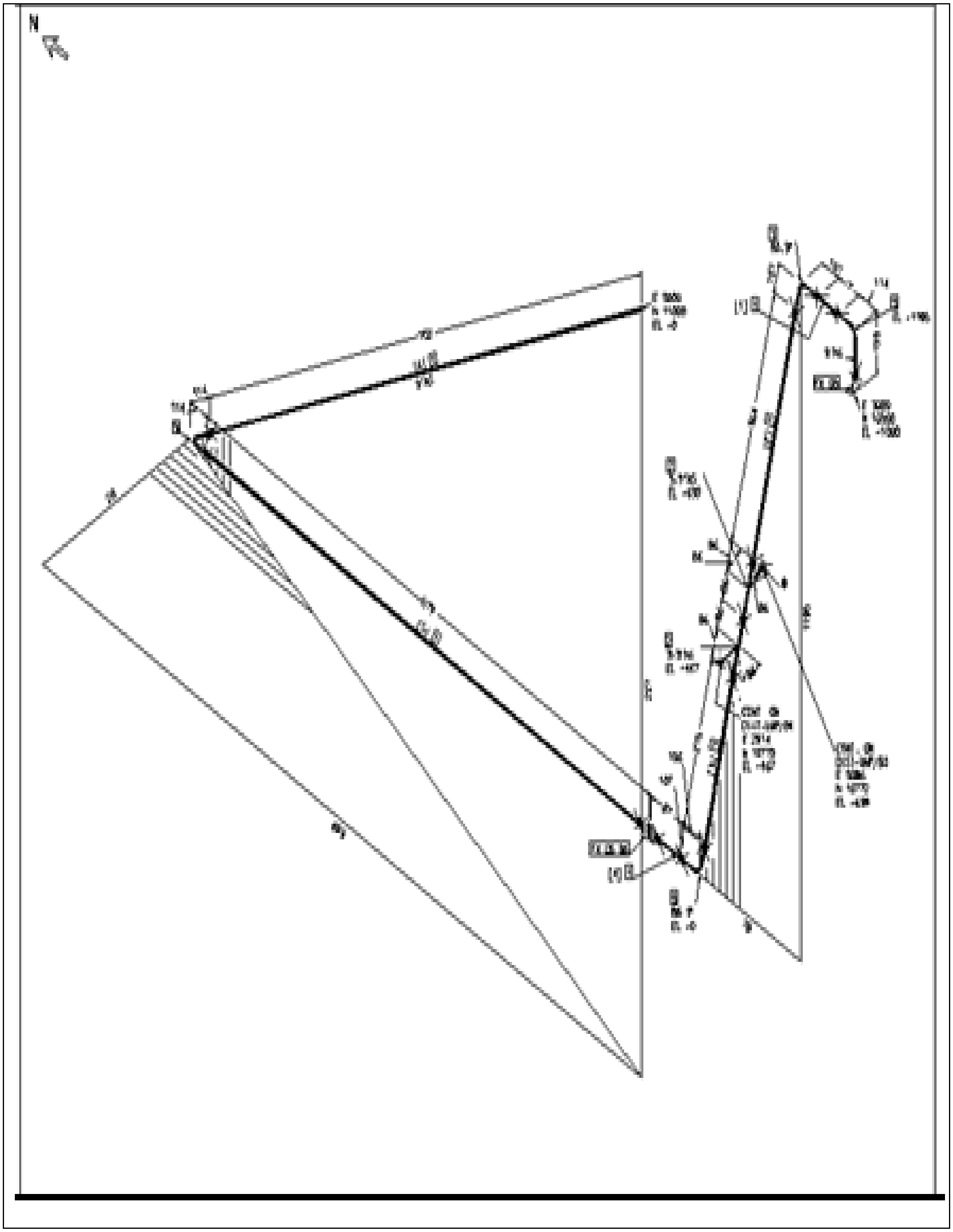
Picture 3

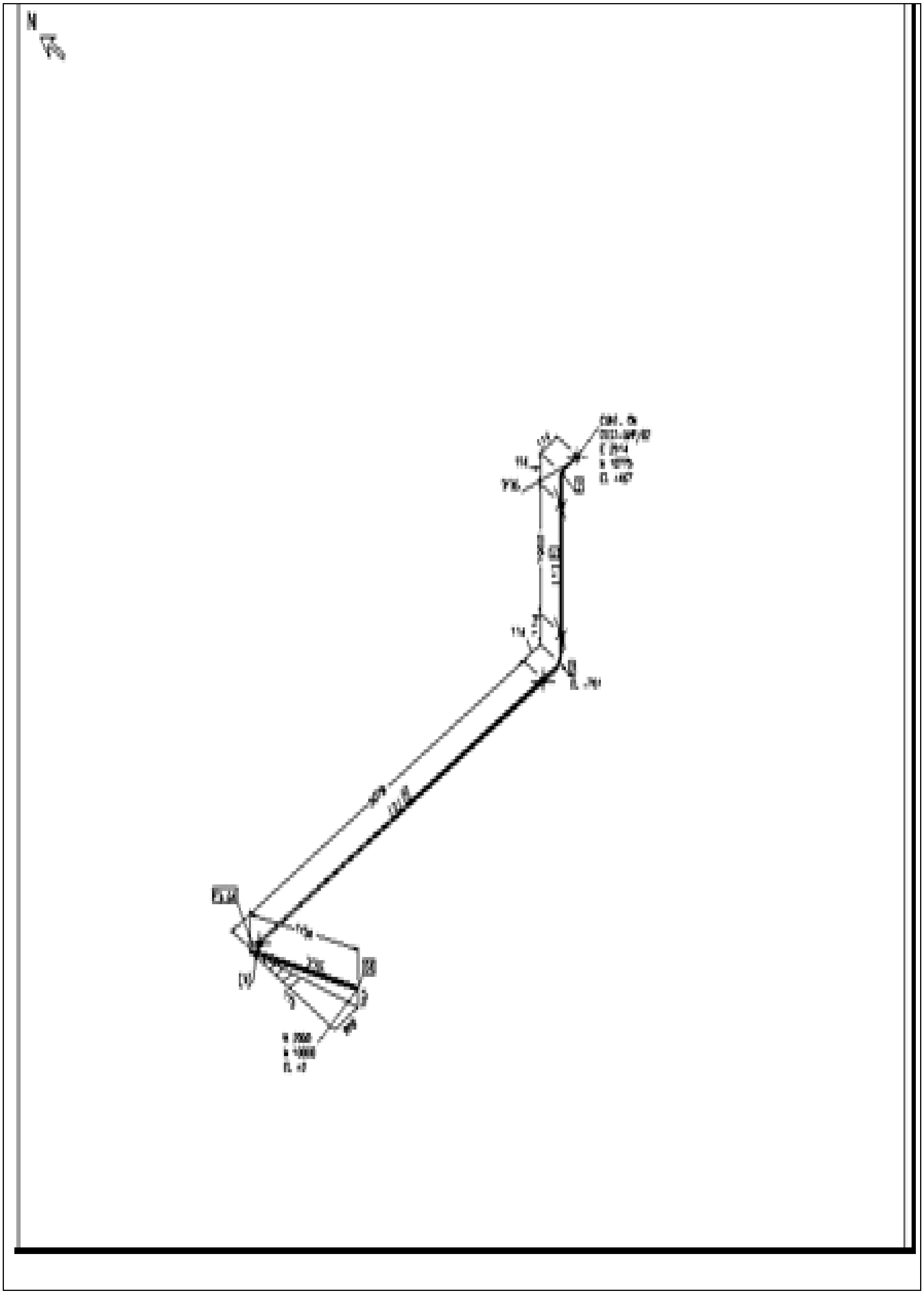
G. Plant Layout Universiti Malaysia Pahang

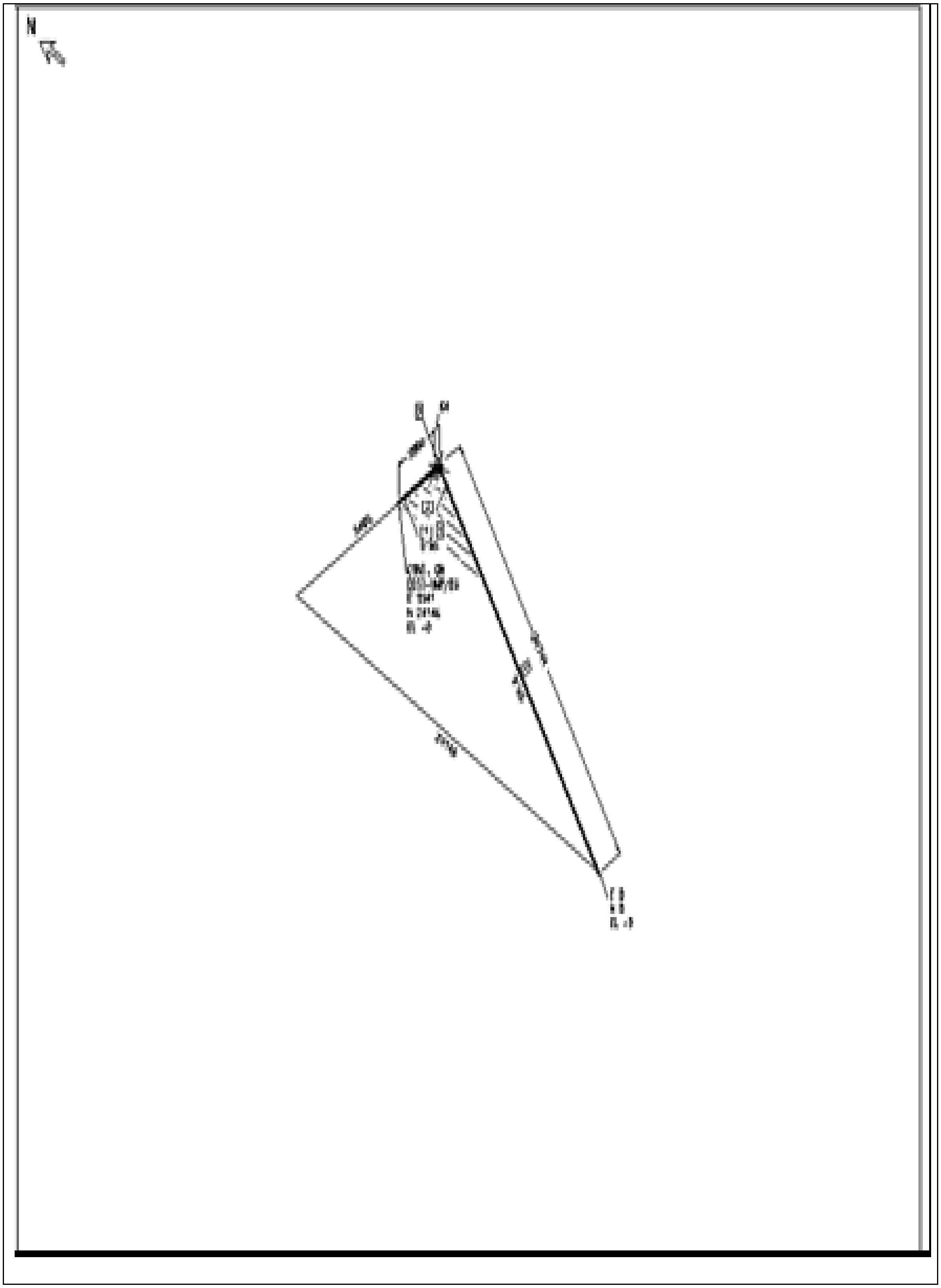


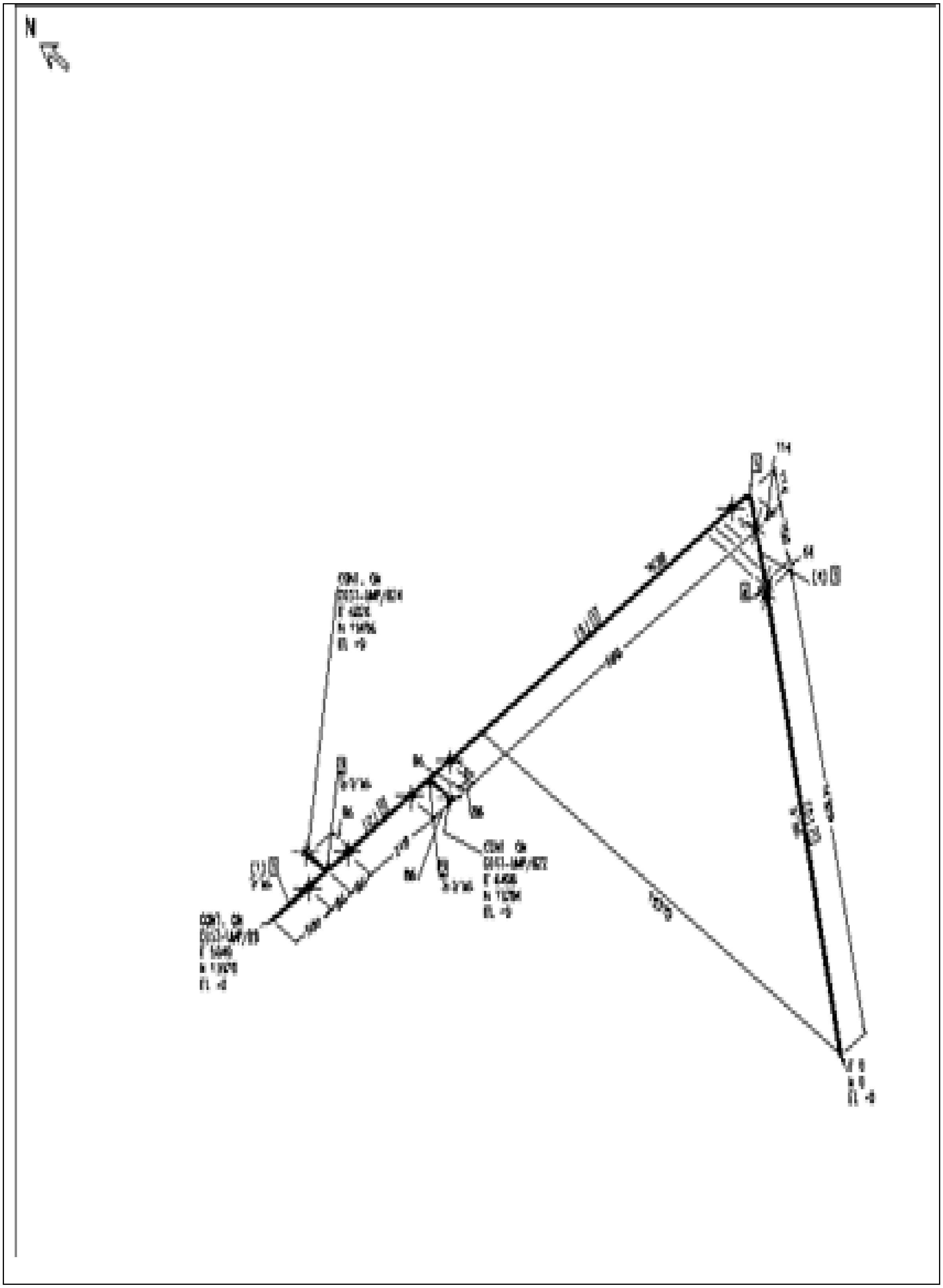
H. PDMS (Isometric Viewe, 2D)

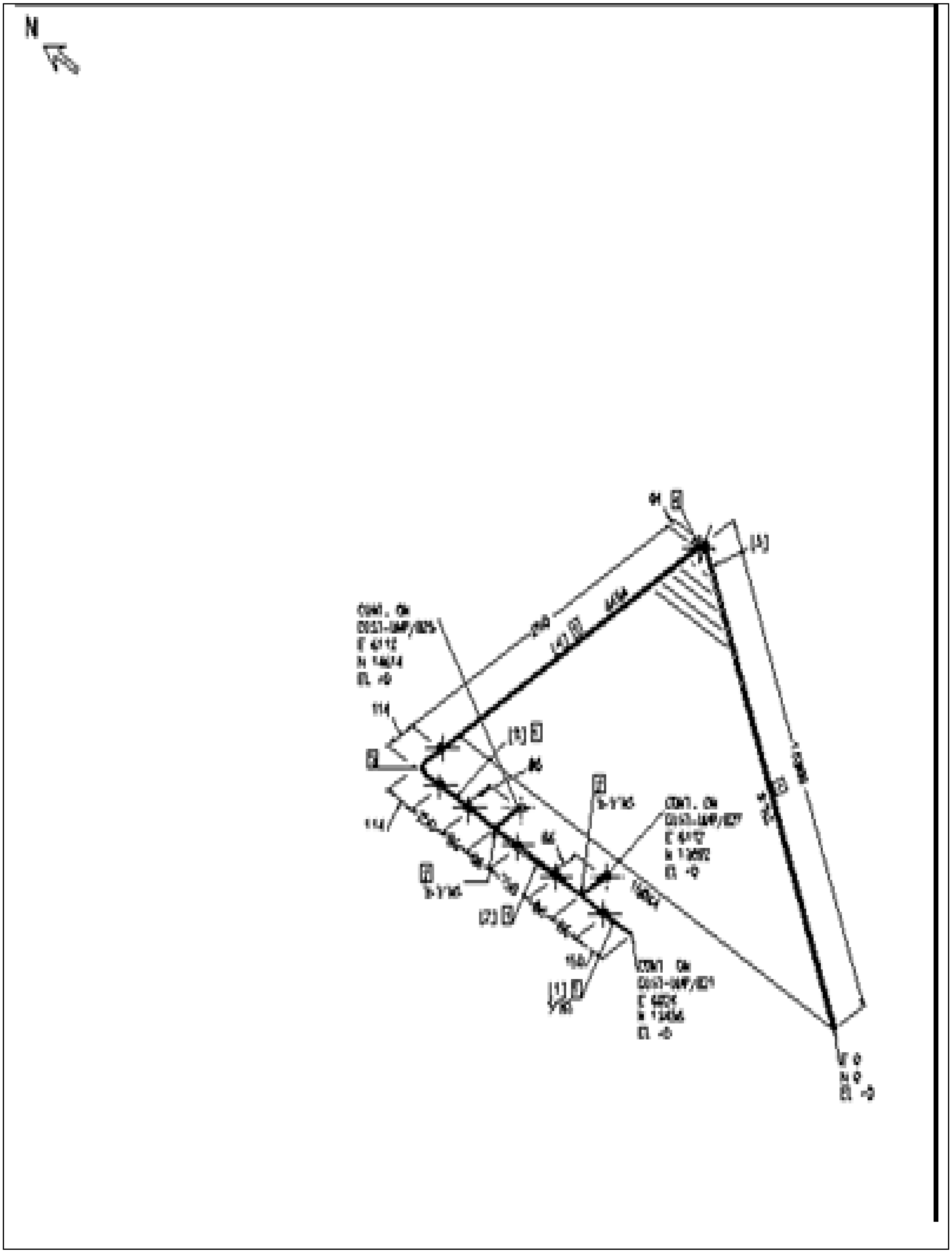








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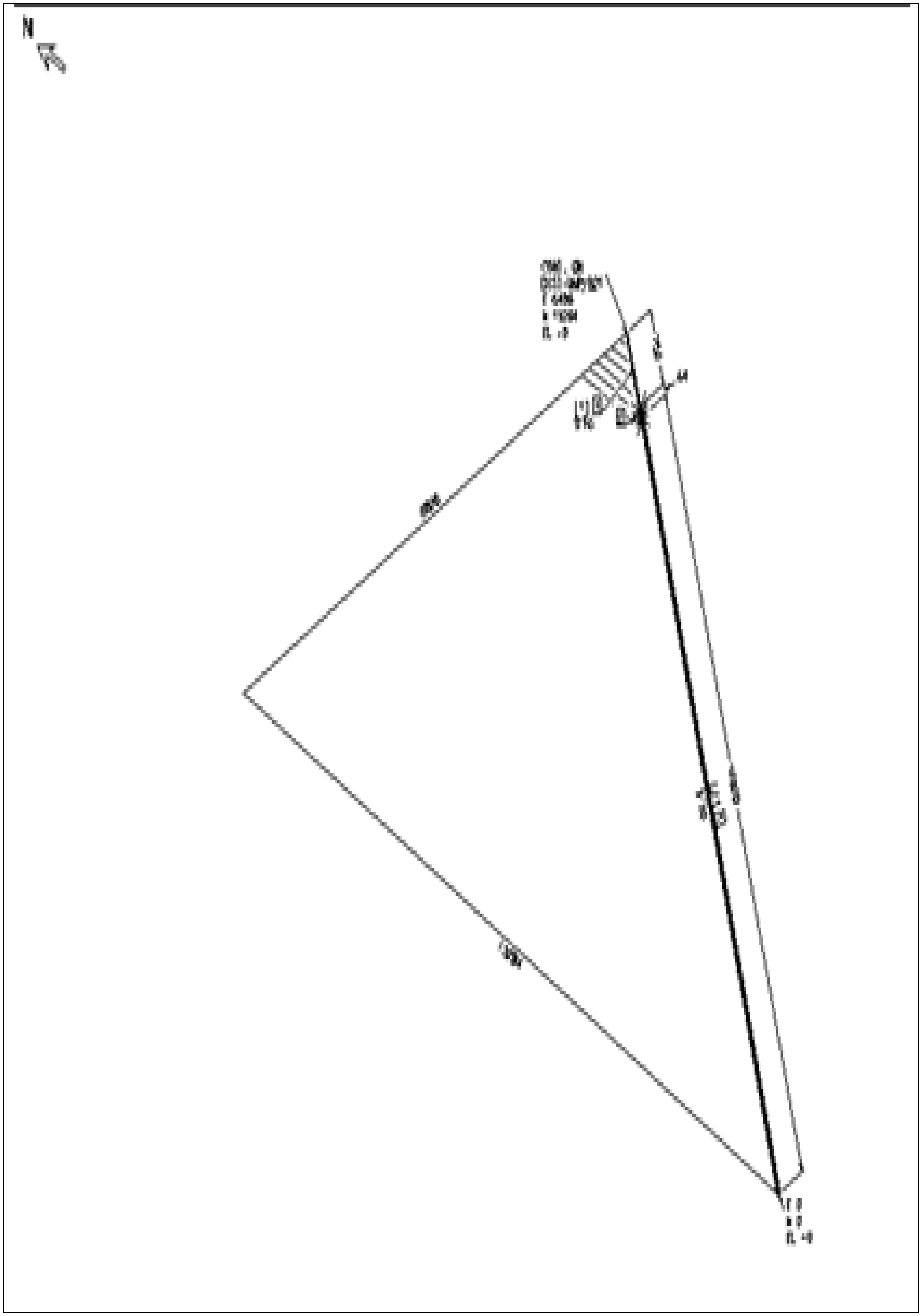

I. Conversions

Pressure units

	Pascal (Pa)	**Bar** (bar)	**Technical atmosphere** (at)	**Atmosphere** (atm)	**Torr** (Torr)	**Pound-force per square inch** (psi)
1 Pa	≡ 1 N/m^2	10^{-5}	1.0197×10^{-5}	9.8692×10^{-6}	7.5006×10^{-3}	145.04×10^{-6}
1 bar	100,000	≡ 10^6 dyn/cm^2	1.0197	0.98692	750.06	14.5037744
1 at	98,066.5	0.980665	≡ 1 kgf/cm^2	0.96784	735.56	14.223
1 atm	101,325	1.01325	1.0332	≡ 1 atm	760	14.696
1 torr	133.322	1.3332×10^{-3}	1.3595×10^{-3}	1.3158×10^{-3}	≡ 1 Torr; ≈ 1 mmHg	19.337×10^{-3}
1 psi	6.894×10^3	68.948×10^{-3}	70.307×10^{-3}	68.046×10^{-3}	51.715	≡ 1 lbf/in^2

Example reading: 1 Pa = 1 N/m^2 = 10^{-5} bar = 10.197×10^{-6} at = 9.8692×10^{-6} atm = 7.5006×10^{-3} torr = 145.04×10^{-6} psi etc.***(x* psig + 14.656 = *x* psia.)**