

## LAMPIRAN

### Lampiran 1. Gambar



**Gambar L1.1** Spesifikasi pompa sentrifugal

( Sumber : Dokumentasi )



**Gambar L1. 2** Cooling tower

( Sumber : Dokumentasi )



1



2



3



4



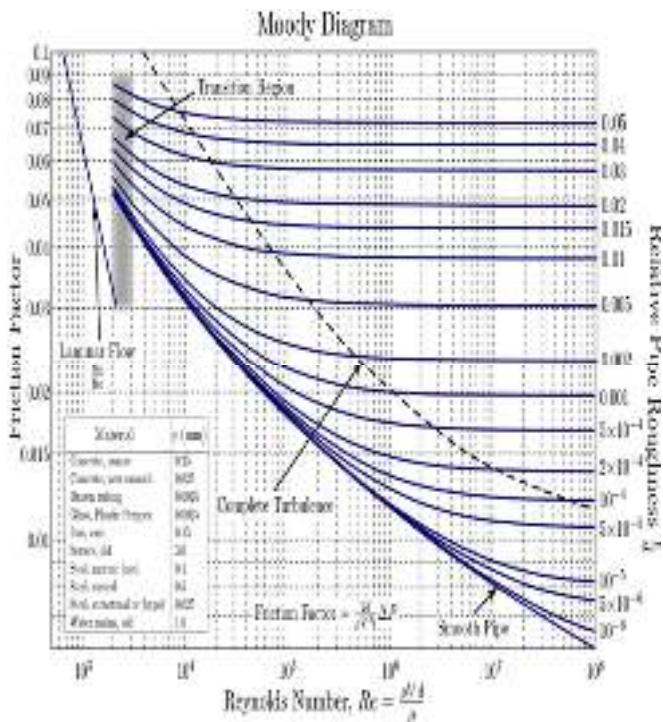
5



6

**Gambar L1. 3** Sistem aliran Cooling tower

( Sumber : Dokumentasi )



**Gambar L1. 4** Moody Diagram

( Sumber : wikipedia )

## Lampiran 2. Tabel

Tabel L2. 1 Harga koefisien Head untuk berbagai peralatan

Tabel L2.1 - Harga koefisien Head untuk berbagai peralatan

Kategori	Koefisien Head	Gambar
1. Pipa	0,02	
Pipa 90° (bengkok)	0,02	
Pipa 45° (bengkok)	0,01	
Pipa 180° (bengkok)	0,02	
2. Pipa masuk ke tangki	0,02	
Pipa masuk ke sisi tangki	0,02	
Pipa masuk ke sisi bawah tangki	0,02	
3. Pipa keluar dari tangki	0,02	
Pipa keluar dari sisi tangki	0,02	
Pipa keluar dari sisi bawah tangki	0,02	
4. Pipa horizontal	0,02	
5. Pipa vertikal	0,02	
Pipa masuk ke sisi atas tangki	0,02	
Pipa masuk ke sisi bawah tangki	0,02	
Pipa keluar dari sisi atas tangki	0,02	
Pipa keluar dari sisi bawah tangki	0,02	
Pipa masuk ke sisi atas tangki (dengan katup)	0,02	
Pipa masuk ke sisi bawah tangki (dengan katup)	0,02	
Pipa keluar dari sisi atas tangki (dengan katup)	0,02	
Pipa keluar dari sisi bawah tangki (dengan katup)	0,02	

Sumber : Suhariyanto, Mekanika Fluida 2008

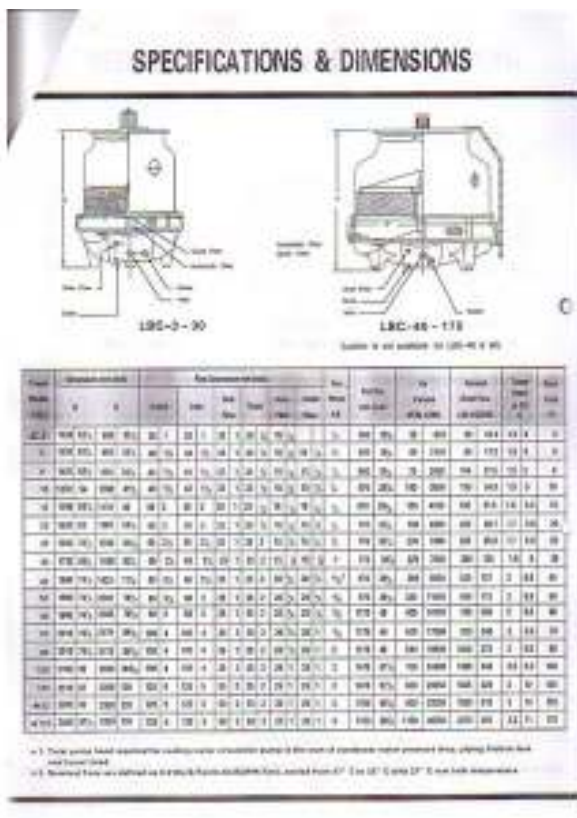
**Tabel L2. 2** Tabel. Roughnes pipa

## ① Pipe Materials and Common Pipe Roughness Values

Material	e (mm)	e (inches)
Concrete	0.3 - 3.0	0.012 - 0.12
Cast Iron	0.26	0.010
Galvanized Iron	0.15	0.006
Asphalted Cast Iron	0.12	0.0048
Commercial or Welded Steel	0.045	0.0018
PVC, Glass, Other Drawn Tubing	0.0015	0.00006

Sumber : <https://www.pipeflow.com/pipe-pressure-drop-calculations/pipe-roughness>

**Tabel L2. 3** Katalog Cooling tower *Liang Chi Industry Co.Ltd*



**Tabel L2. 4** Sifat sifat fisik air ( Air dibawah 1 atm dan air jenuh diatas 100° C )

2 Spesifikasi

**Tabel 2.12** Sifat-sifat fisik air (Air di bawah 1 atm, dan air jenuh di atas 100°C).

Temperatur (°C)	Kerapatan (kg/l)	Viskositas kinematik (m <sup>2</sup> /s)	Tekanan uap jenuh (kgf/cm <sup>2</sup> )
0	0,9998	$1,792 \times 10^{-6}$	0,00623
5	1,0000	1,520	0,00889
10	0,9998	1,307	0,01251
20	0,9983	1,004	0,02383
30	0,9957	0,801	0,04325
40	0,9923	0,658	0,07520
50	0,9880	0,554	0,12578
60	0,9832	0,475	0,20313
70	0,9777	0,413	0,3178
80	0,9716	0,365	0,4829
90	0,9652	0,326	0,7149
100	0,9581	0,295	1,0332
120	0,9431	0,244	2,0246
140	0,9261	0,211	3,685
160	0,9073	0,186	6,303
180	0,8869	0,168	10,224
200	0,8647	0,155	15,855
220	0,8403	0,150	23,656
240	0,814	0,136	34,138
260	0,784	0,131	47,869
280	0,751	0,128	65,468
300	0,712	0,127	87,621

Catatan: 1 atm = 101,3 kPa    1 kgf/cm<sup>2</sup> = 98,1 kPa

**Tabel 2.13** Sifat-sifat fisik beberapa zat cair.

(a) Berat per satuan volume

(Sumber : Sularo 1983)



**Table L2. 5** Moody Chart Calculator 4 inci


[www.EngineeringSite](#)

### Moody Chart Calculator

Reynolds number:

Relative roughness:

friction factor:

 Try the free Moody Chart Calculator app for Android on the Google play [store](#)

Learn more about the Moody Chart Calculator, [here](#).

Sumber : [http://www.advdelpsys.com/michael\\_maley/moody\\_chart/](http://www.advdelpsys.com/michael_maley/moody_chart/)

**Tabel L2. 6** Moody Chart Calculator 8 inchi


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## Moody Chart Calculator

Turbulent number:

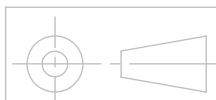
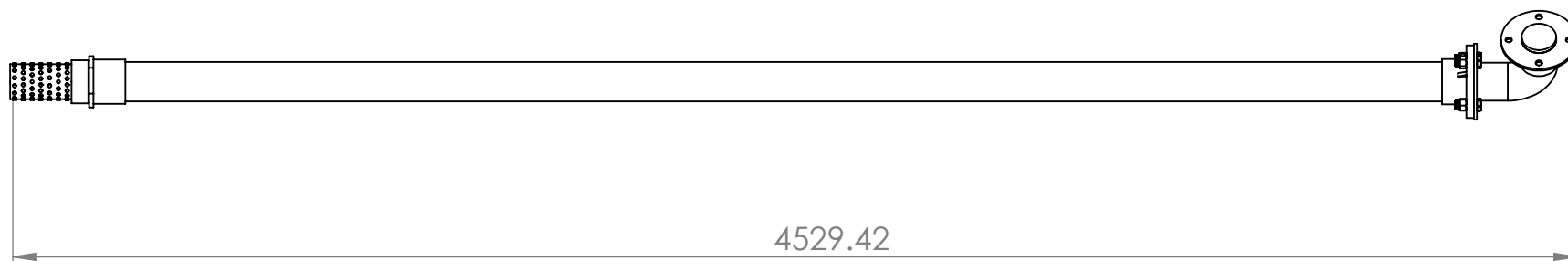
Relative roughness:

friction factor:

 Try the Free Moody Chart Calculator app for Android at the Google play: [here!](#)

Learn more about the Moody Chart Calculator: [here](#)

Sumber : [http://www.advdelpthisys.com/michael\\_maley/moody\\_chart/](http://www.advdelpthisys.com/michael_maley/moody_chart/)



Skala : 1 : 20  
Satuan : mm  
Tanggal : 11-01-2019

Digambar : Juhan Budi U  
Fakultas : Teknik Mesin  
Diperiksa : Ir. Anastas R, MT.

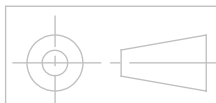
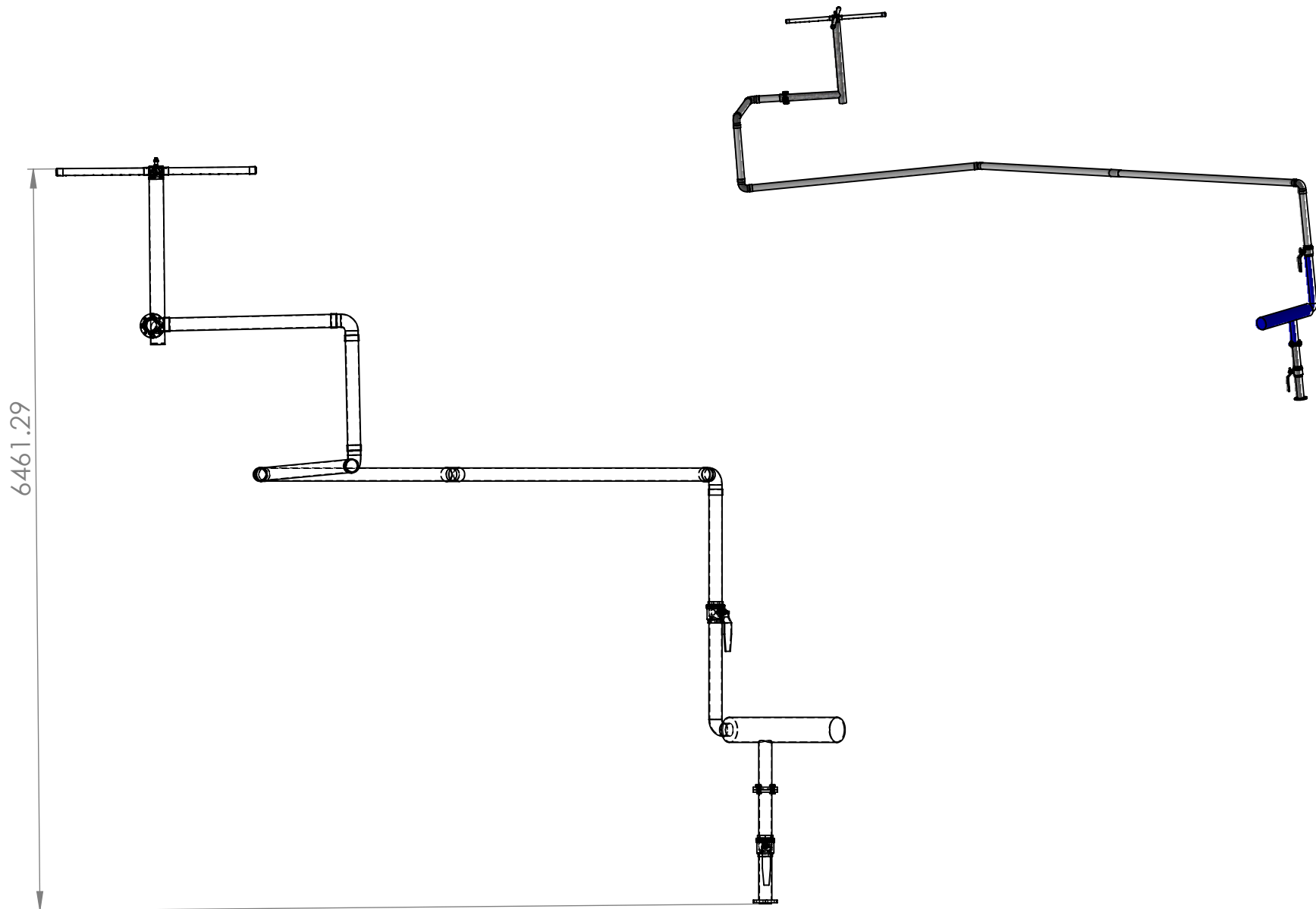
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PIPA HISAP

Gambar L3.1

A4



Skala : 1 : 100

Satuan : mm

Tanggal : 11-01-2019

Digambar : Juhan Budi U

Fakultas : Teknik Mesin

Diperiksa : Ir. Anastas R, MT.

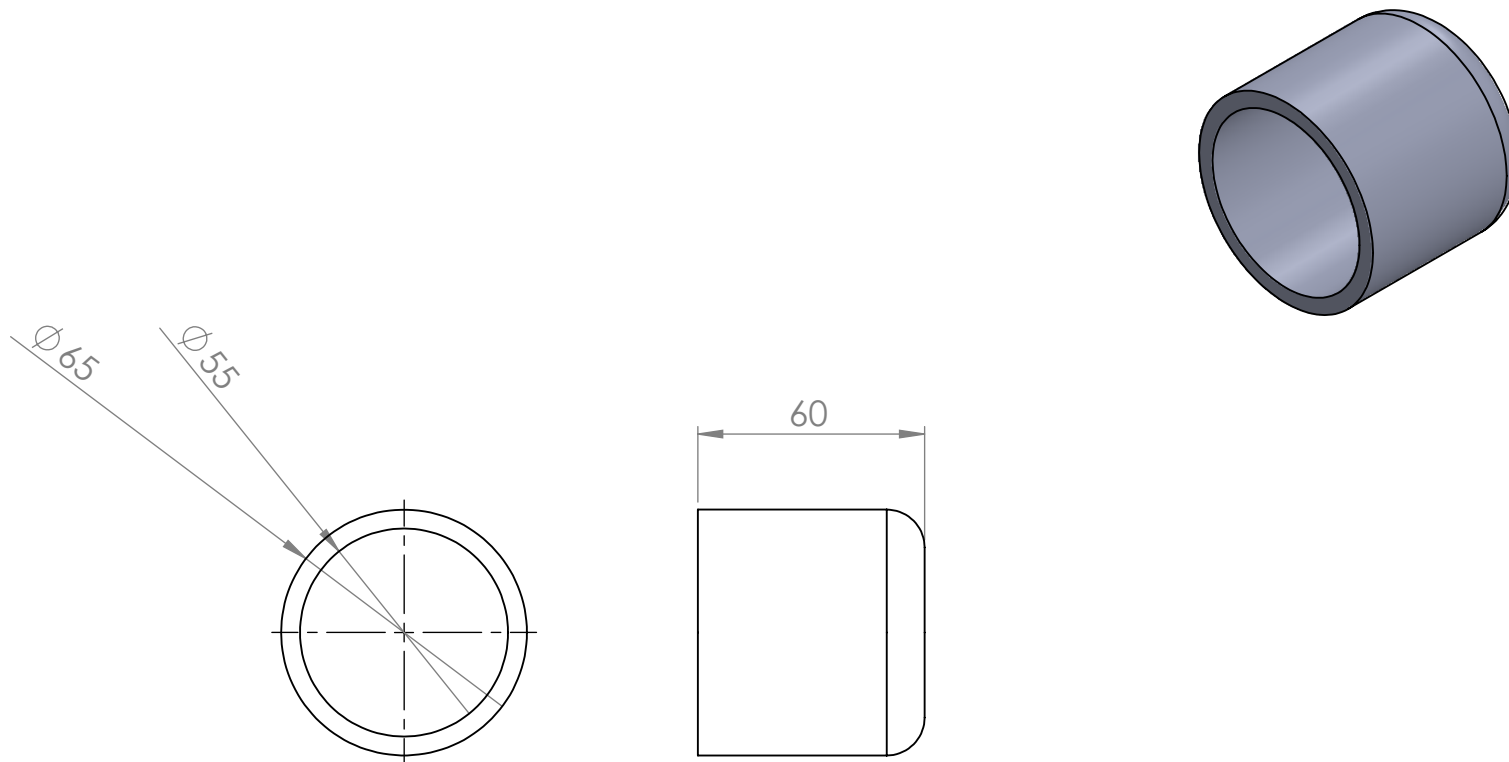
Keterangan :

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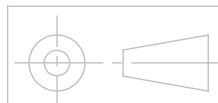
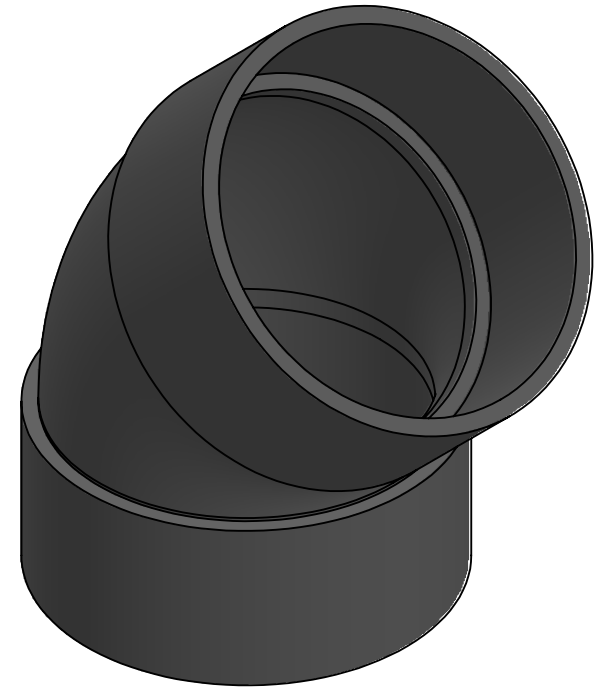
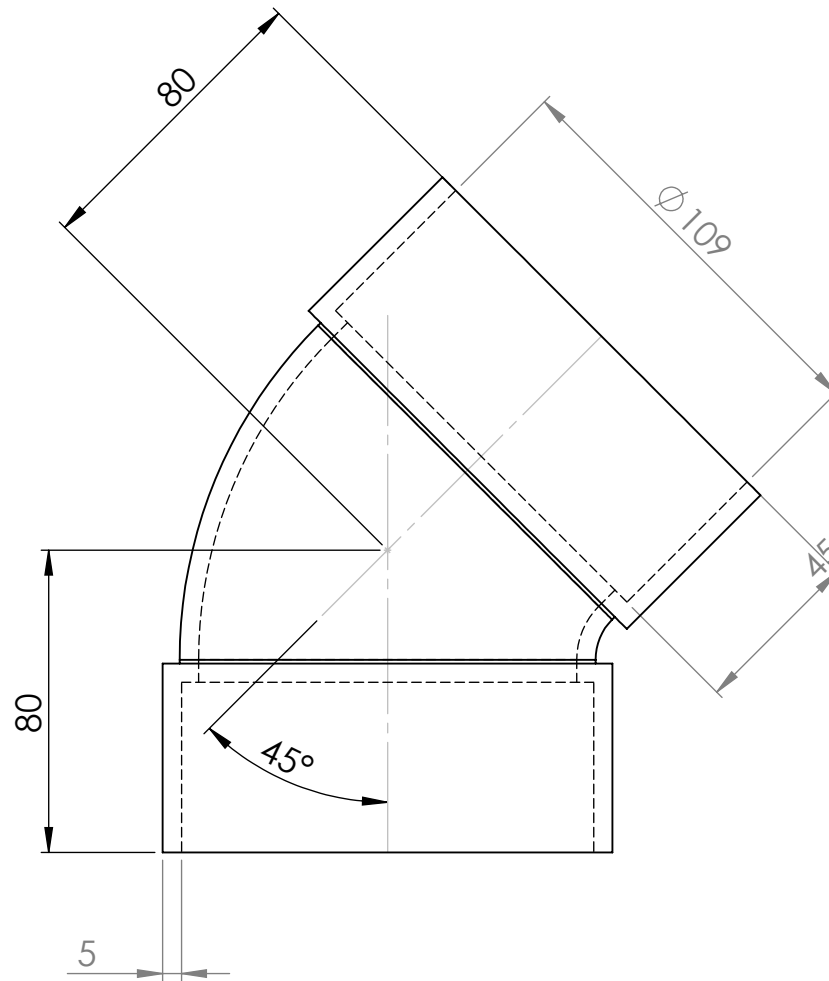
PIPA TEKAN

Gambar L3.2

A4



	Skala : 1 : 2	Digambar : Juhan Budi U	Keterangan :		
	Satuan : mm	Fakultas : Teknik Mesin			
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.			
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>		<b>CAP AW 2"</b>		Gambar L3.3	<b>A4</b>



Skala : 1 : 2  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

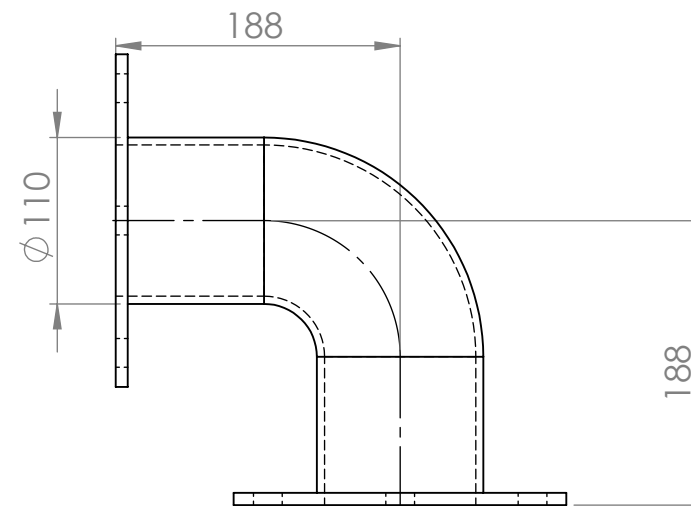
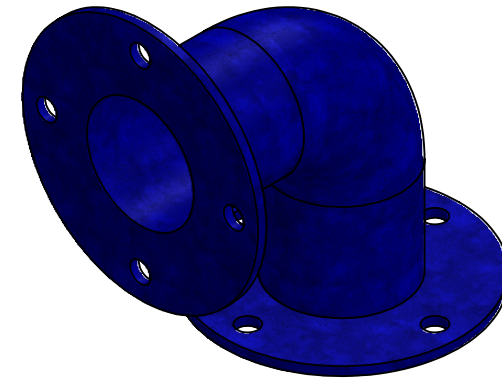
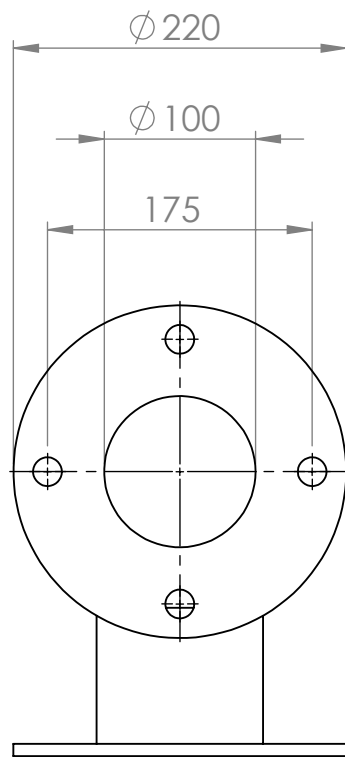
Keterangan :

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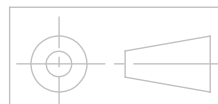
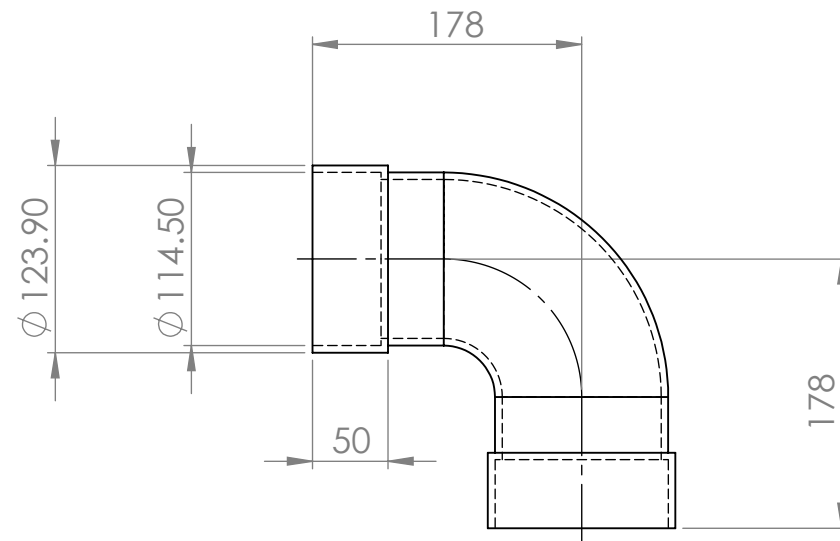
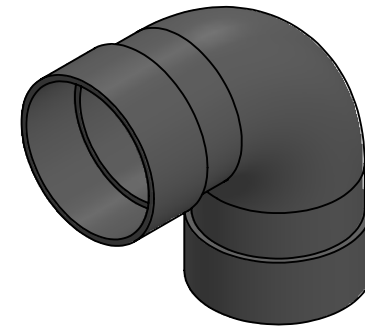
ELBOW AW 4"

Gambar L3.4

A4



	Skala : 1 : 5	Digambar : Juhan Budi U	Keterangan :		
	Satuan : mm	Fakultas : Teknik Mesin			
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.			
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>		<b>ELBOW DENGAN FLANGE 4"</b>		Gambar L3.5	<b>A4</b>



Skala : 1 : 5  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

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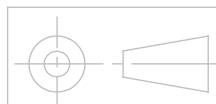
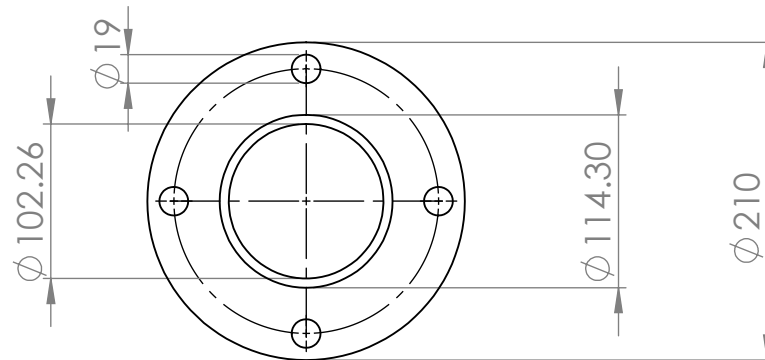
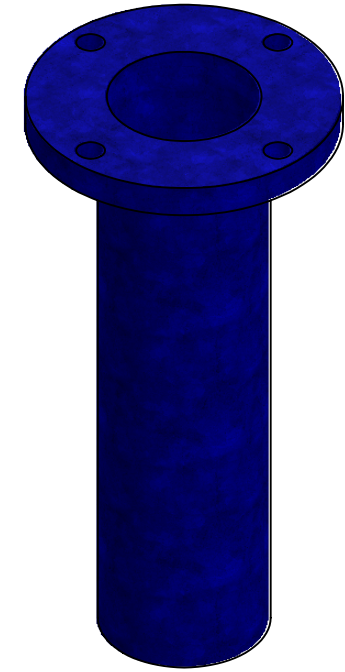
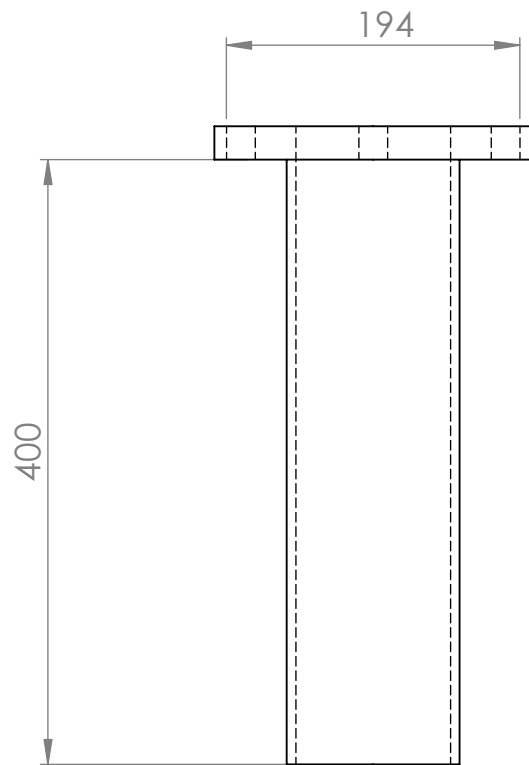
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ELBOW AW 4"

Gambar L3.6

A4





Skala : 1 : 5  
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 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

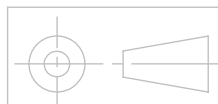
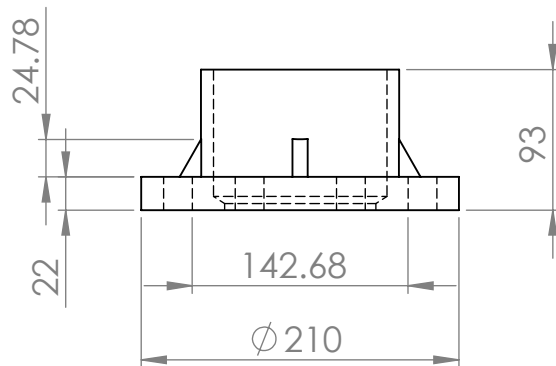
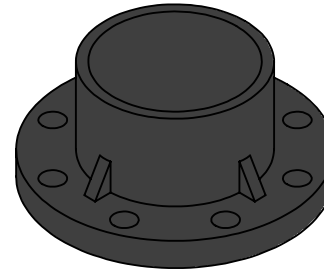
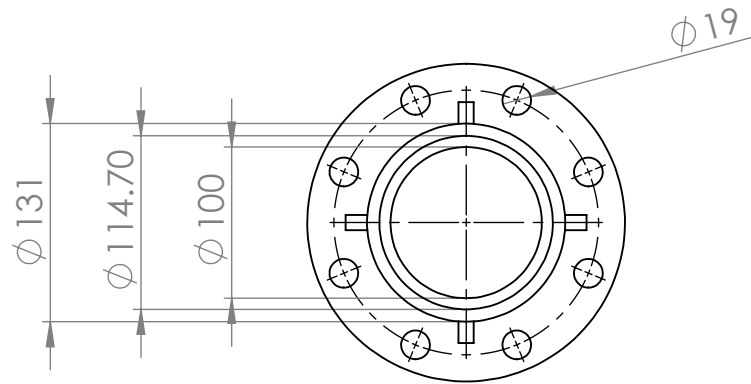
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PIPA TEKAN 400 MM 4"

Gambar L3.7

A4



Skala : 1 : 5  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

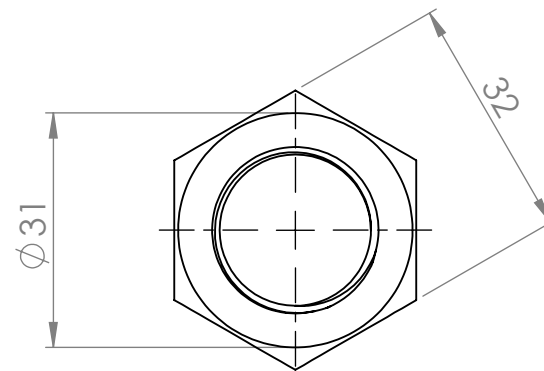
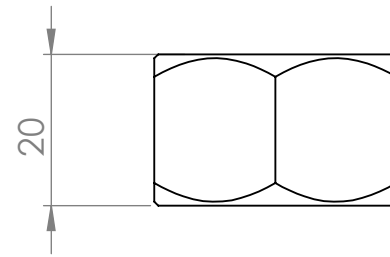
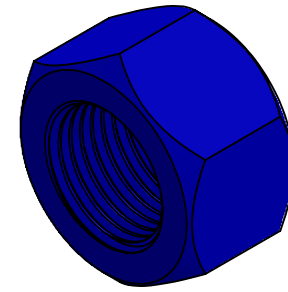
Keterangan :

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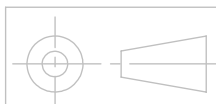
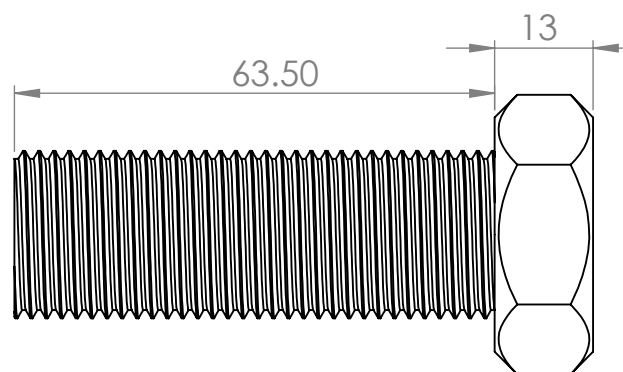
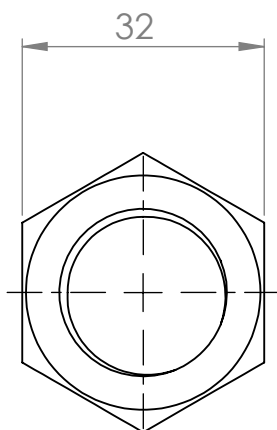
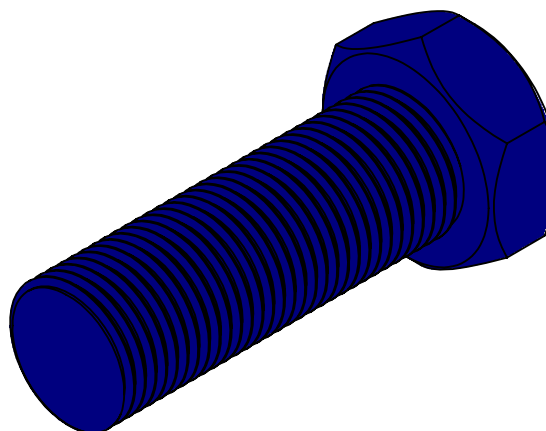
FLANGE PVC 4"

Gambar L3.8

A4



	Skala : 1 : 1	Digambar : Juhan Budi U	Keterangan :		
	Satuan : mm	Fakultas : Teknik Mesin			
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.			
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>		<b>MUR 19 MM (METRIK)</b>		Gambar L3.9	<b>A4</b>



Skala : 1 : 1  
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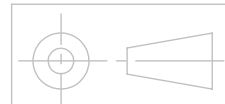
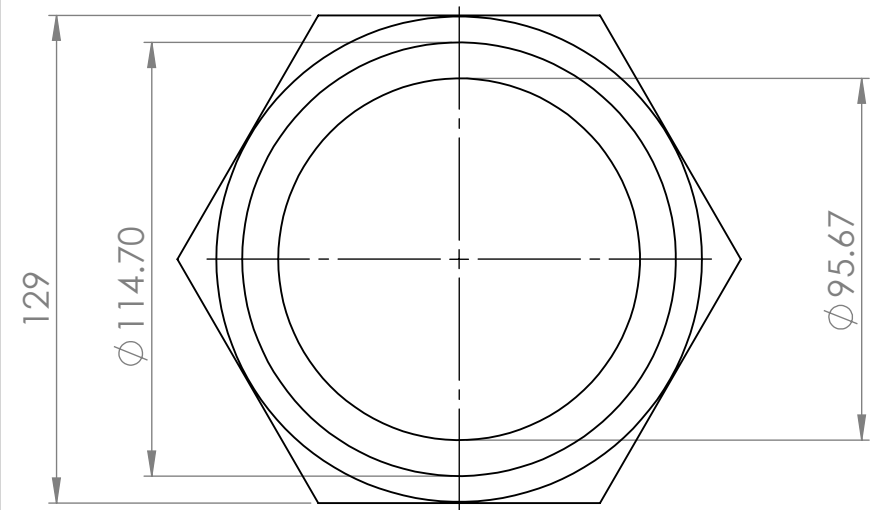
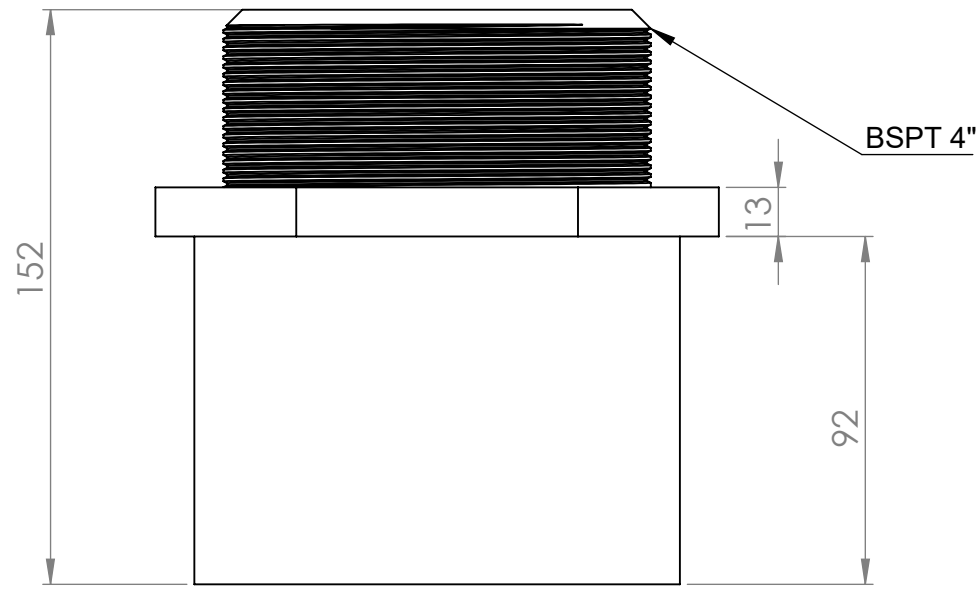
Keterangan :

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BAUT 19 MM (METRIK)

Gambar L3.10

A4



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Satuan : mm	Fakultas : Teknik Mesin
Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.

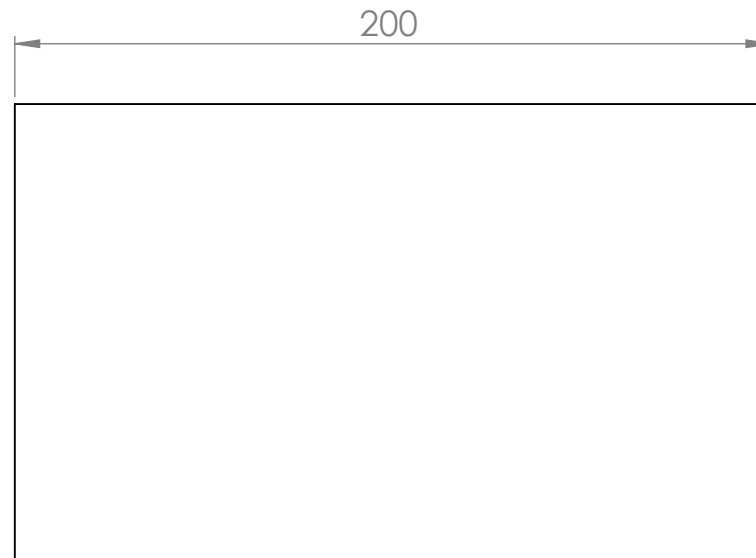
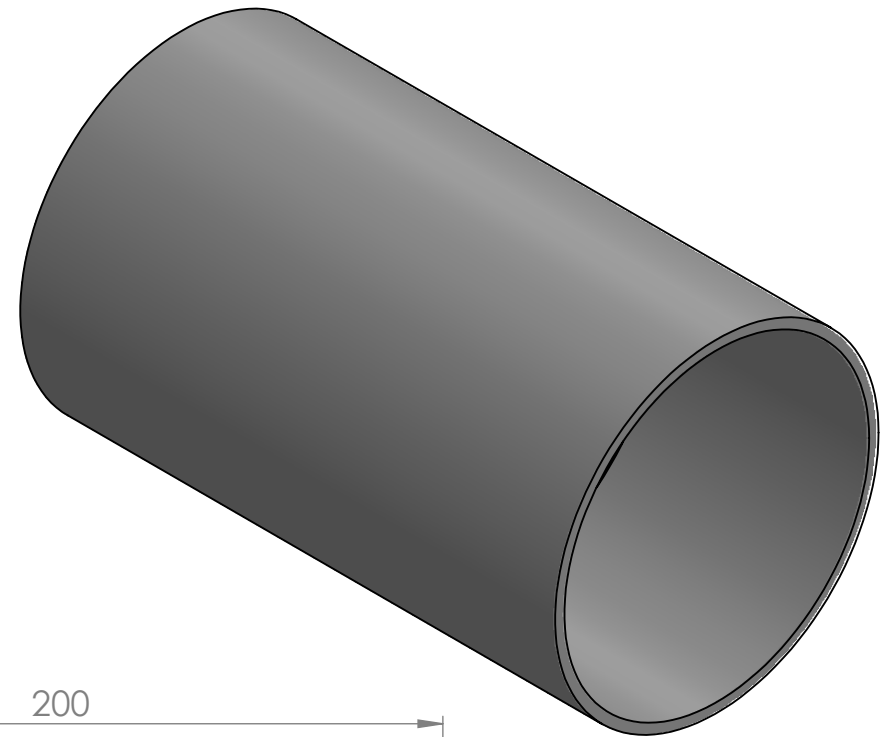
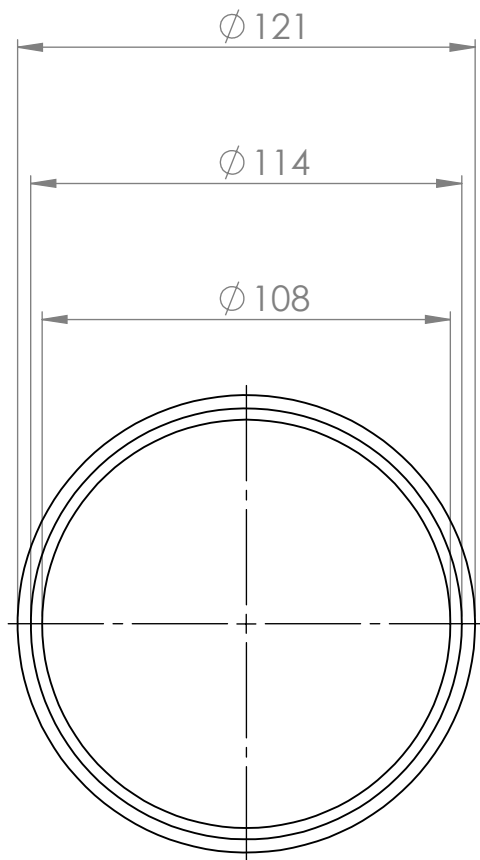
Keterangan :

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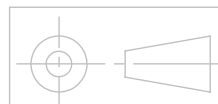
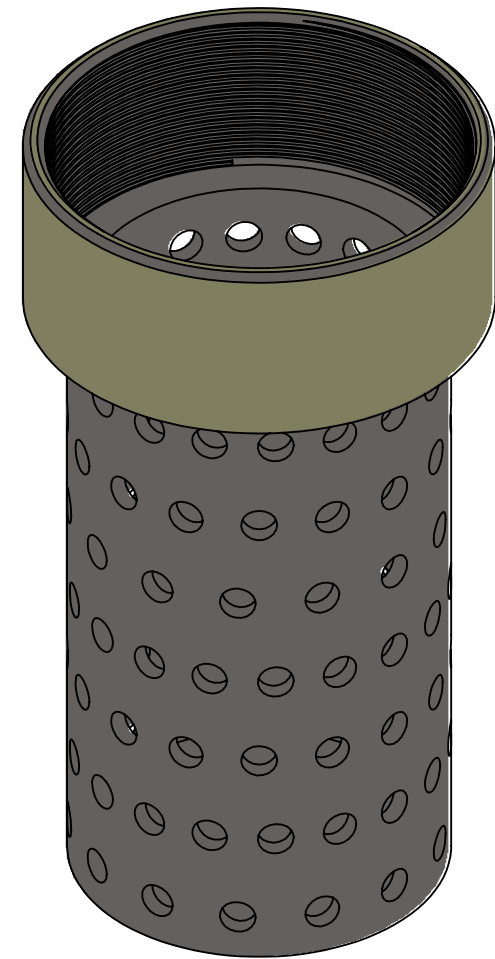
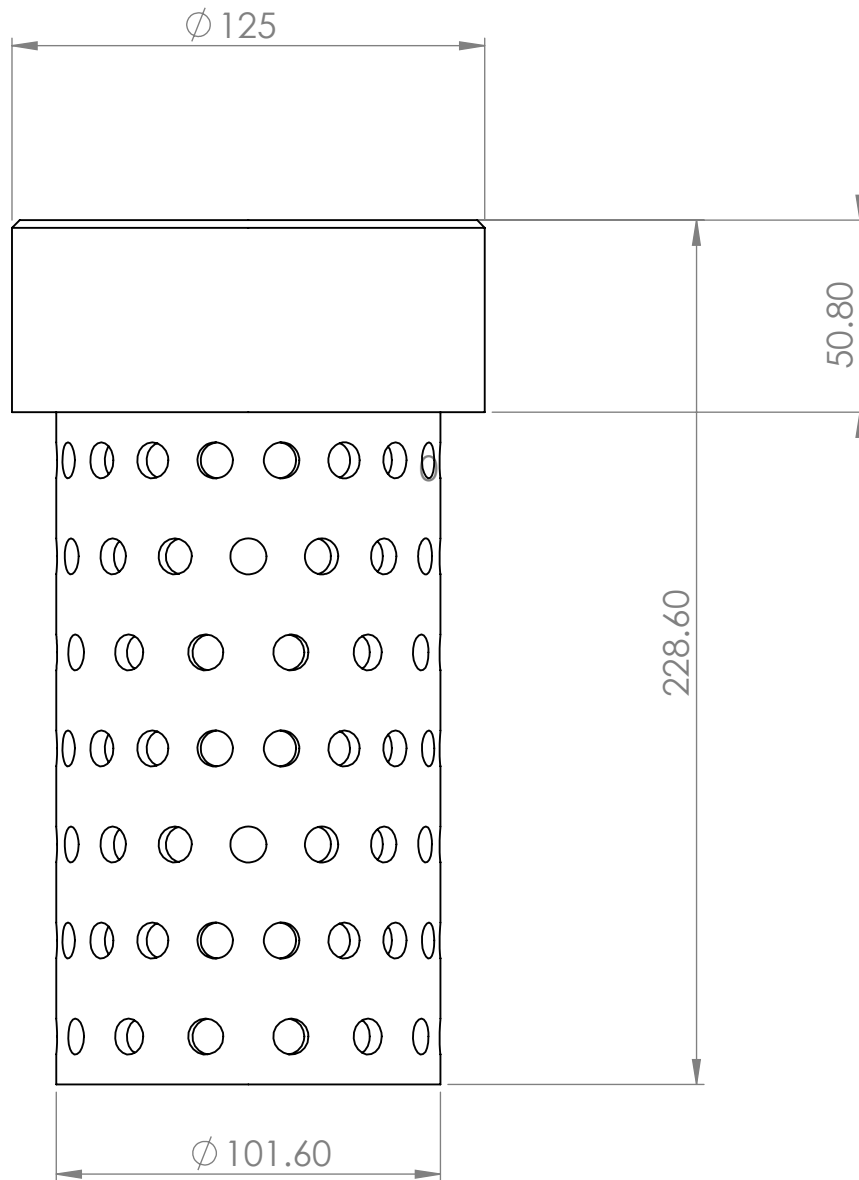
VALVE SHOCKET AW 4"

Gambar L3.11

A4



	Skala : 1 : 2	Digambar : Juhan Budi U	Keterangan :		
	Satuan : mm	Fakultas : Teknik Mesin			
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.			
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>		SHOCK 4"		Gambar L3.12	A4



Skala : 1 : 2  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

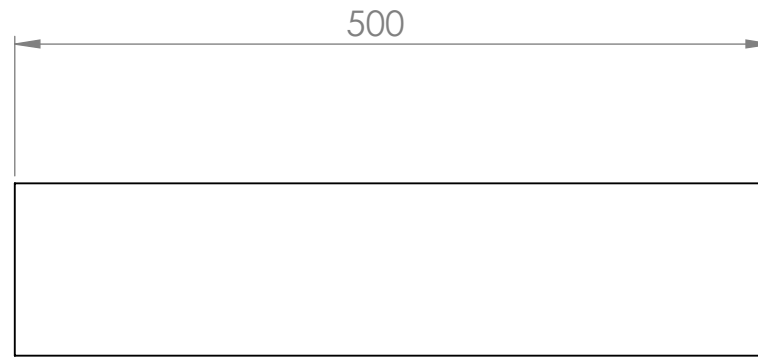
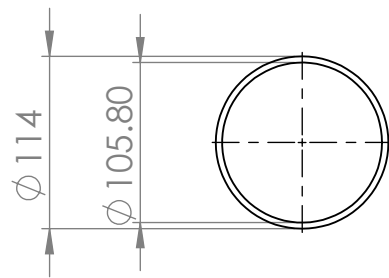
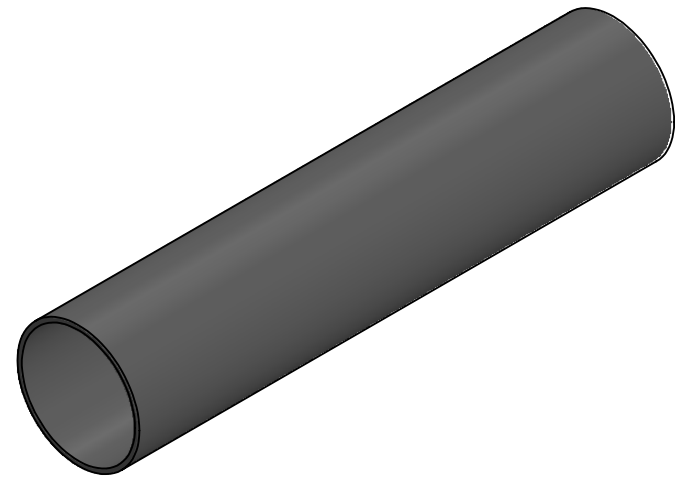
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STRAINER

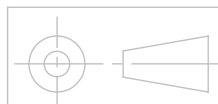
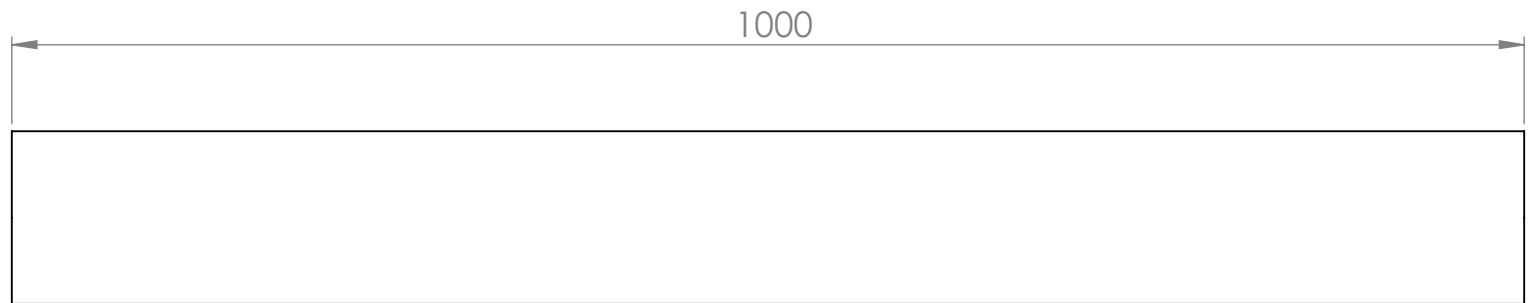
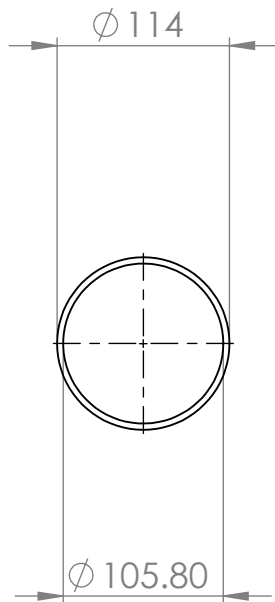
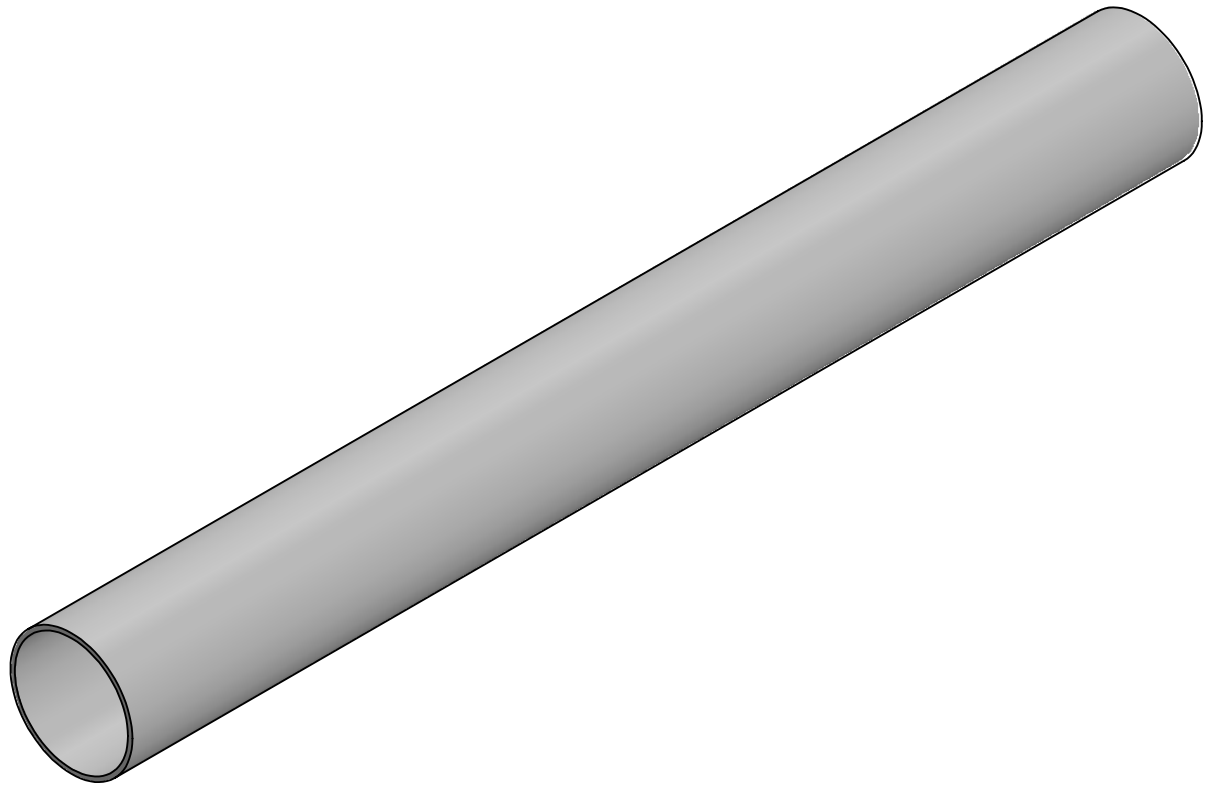
Gambar L3.13

A4



	Skala : 1 : 5	Digambar : Juhan Budi U	Keterangan :	
	Satuan : mm	Fakultas : Teknik Mesin		
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.		
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>	PIPA AW 4" 50 CM		Gambar L3.16	A4





Skala : 1 : 5  
Satuan : mm  
Tanggal : 11-01-2019

Digambar : Juhan Budi U  
Fakultas : Teknik Mesin  
Diperiksa : Ir. Anastas R, MT.

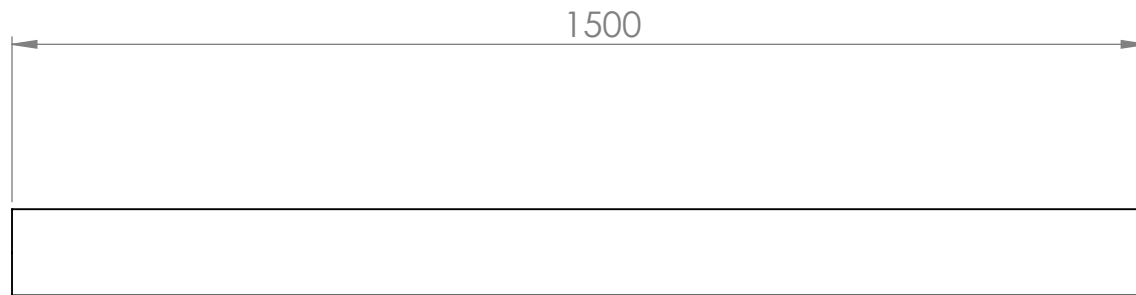
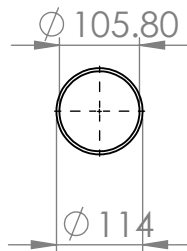
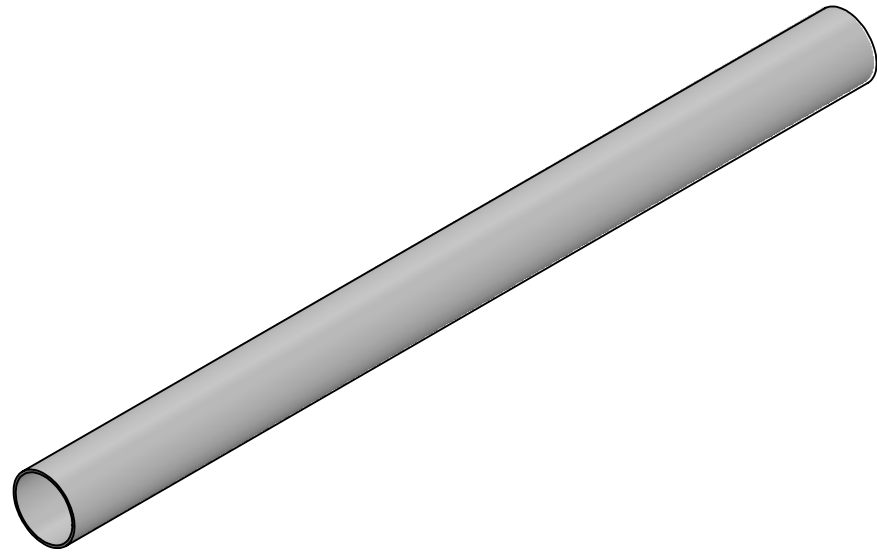
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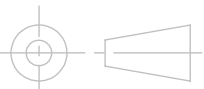
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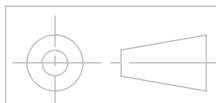
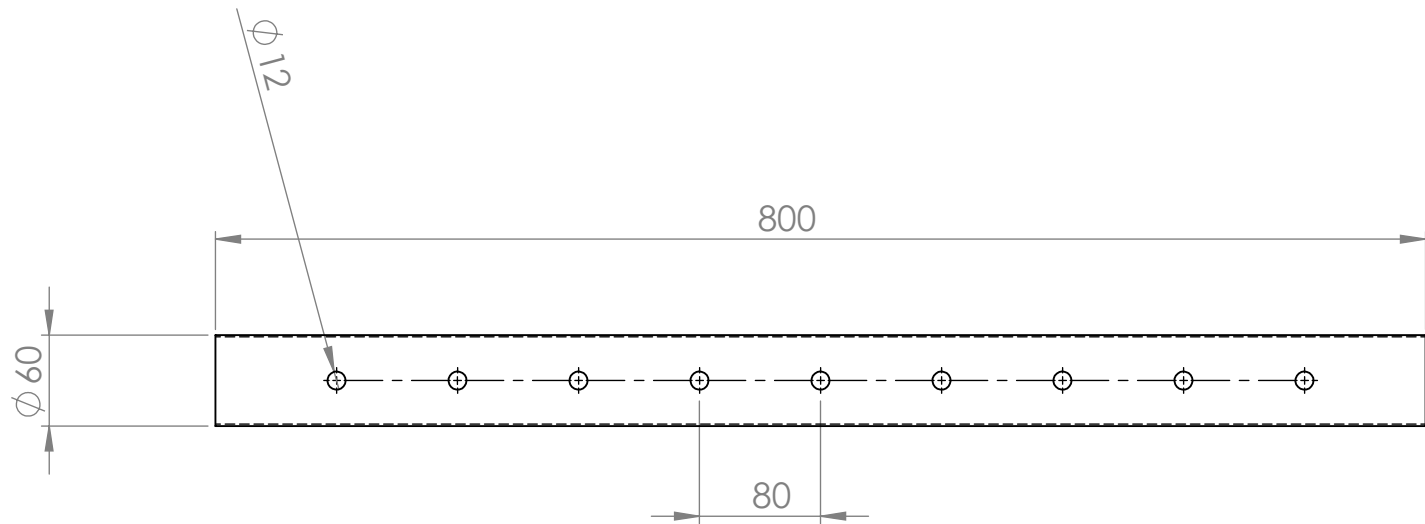
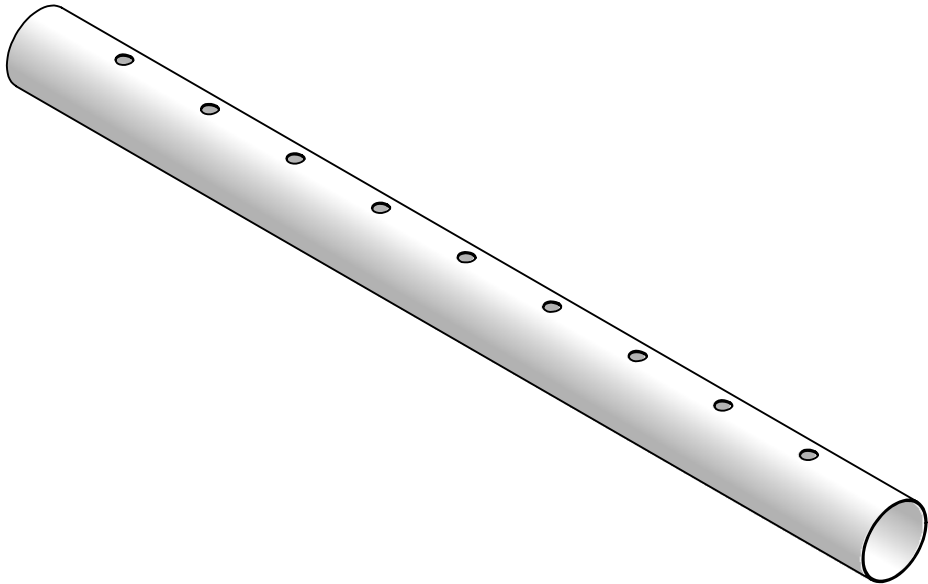
PIPA AW 4" 100 CM

Gambar L3.17

A4



	Skala : 1 : 10	Digambar : Juhan Budi U	Keterangan :	
	Satuan : mm	Fakultas : Teknik Mesin		
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.		
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>	PIPA AW 4" 150 CM		Gambar L3.18	A4



Skala : 1 : 5  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

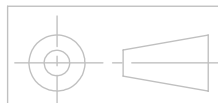
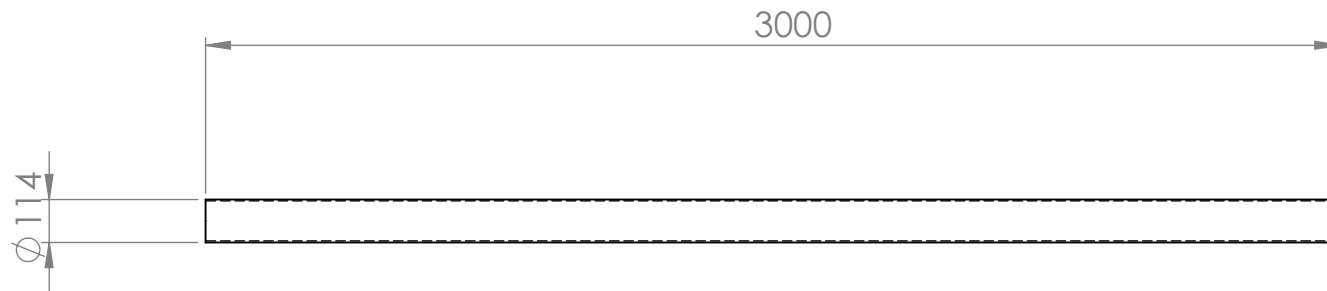
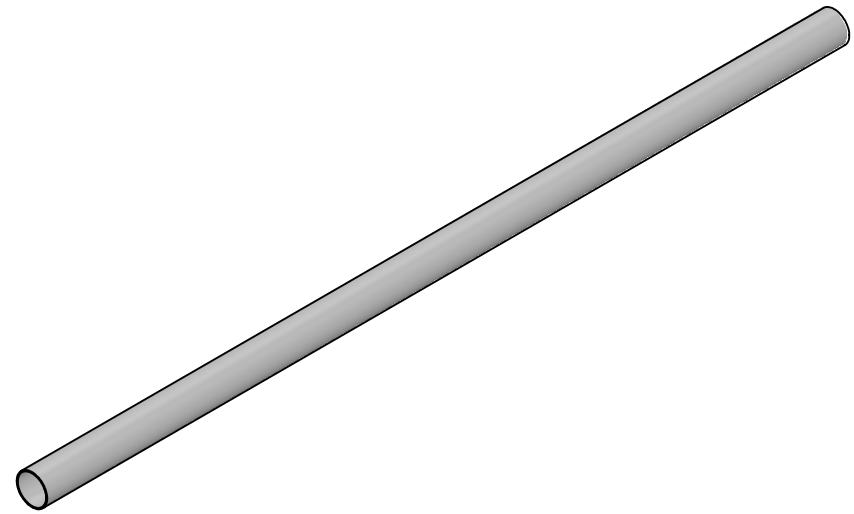
Keterangan :

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PIPA AW 2" SPRINKLER

Gambar L3.19

A4



Skala : 1 : 20  
Satuan : mm  
Tanggal : 11-01-2019

Digambar : Juhan Budi U  
Fakultas : Teknik Mesin  
Diperiksa : Ir. Anastas R, MT.

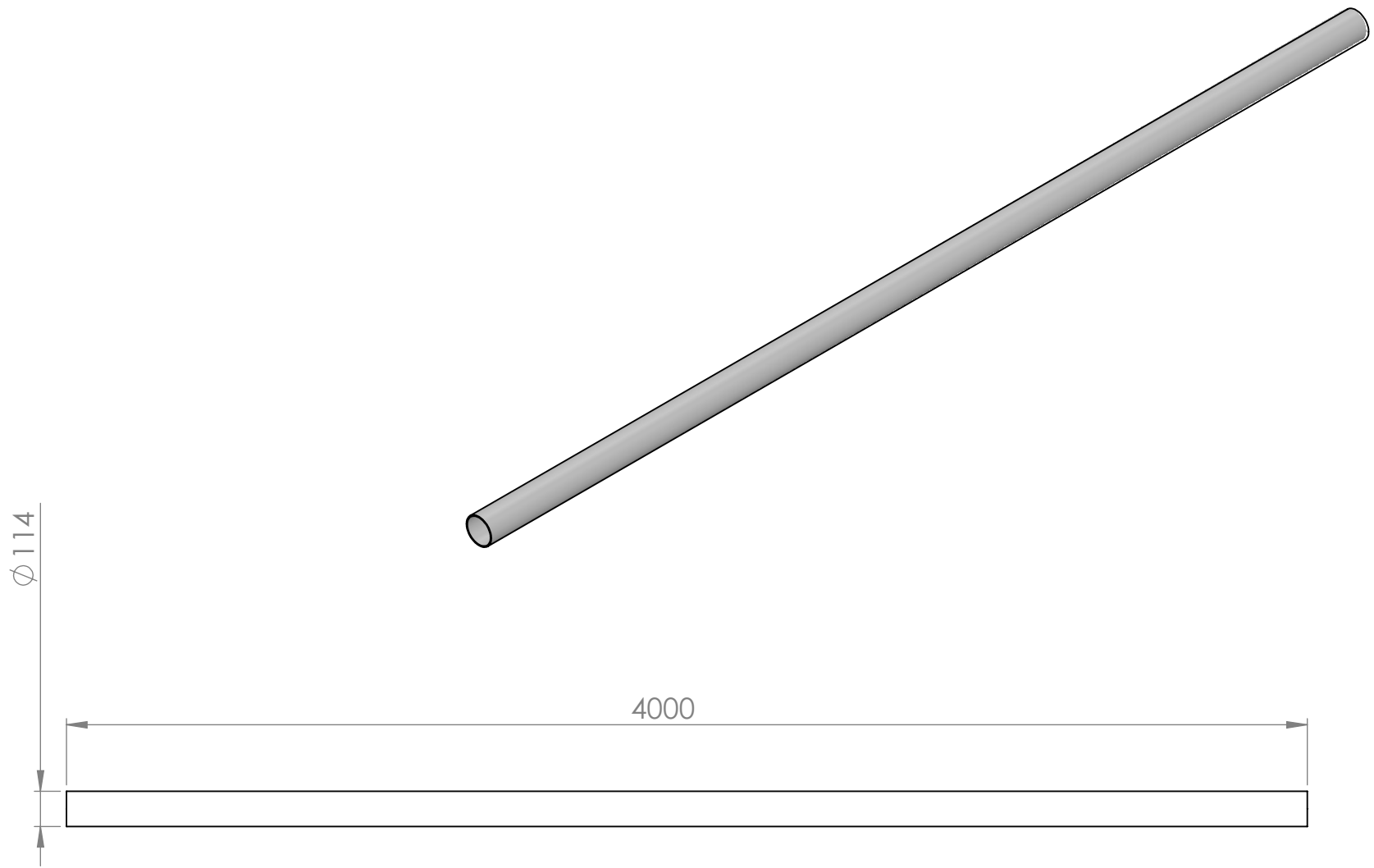
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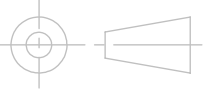
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SURABAYA**

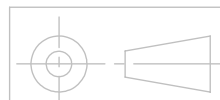
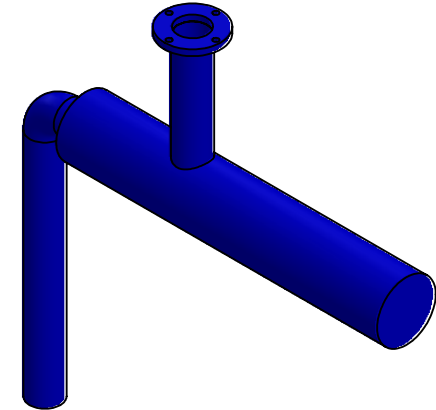
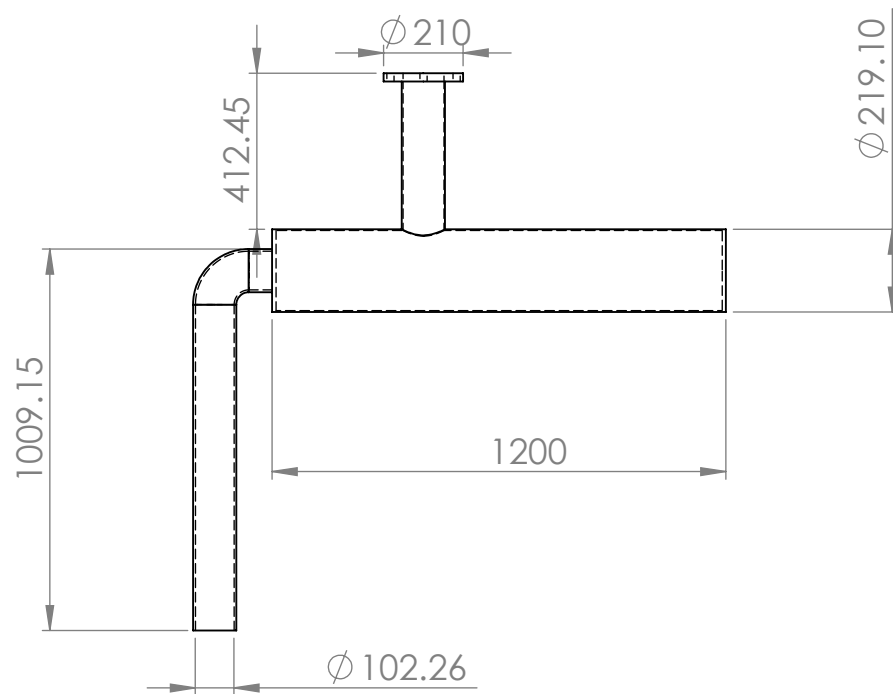
PIPA AW 4" 3 M

Gambar L.3.20

A4



	Skala : 1 : 20	Digambar : Juhan Budi U	Keterangan :		
	Satuan : mm	Fakultas : Teknik Mesin			
	Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.			
<b>UNIVERSITAS MUHAMMADIYAH SURABAYA</b>		PIPA AW 4" 4M		Gambar L3.21	<b>A4</b>



Skala : 1 : 20  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

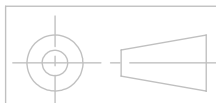
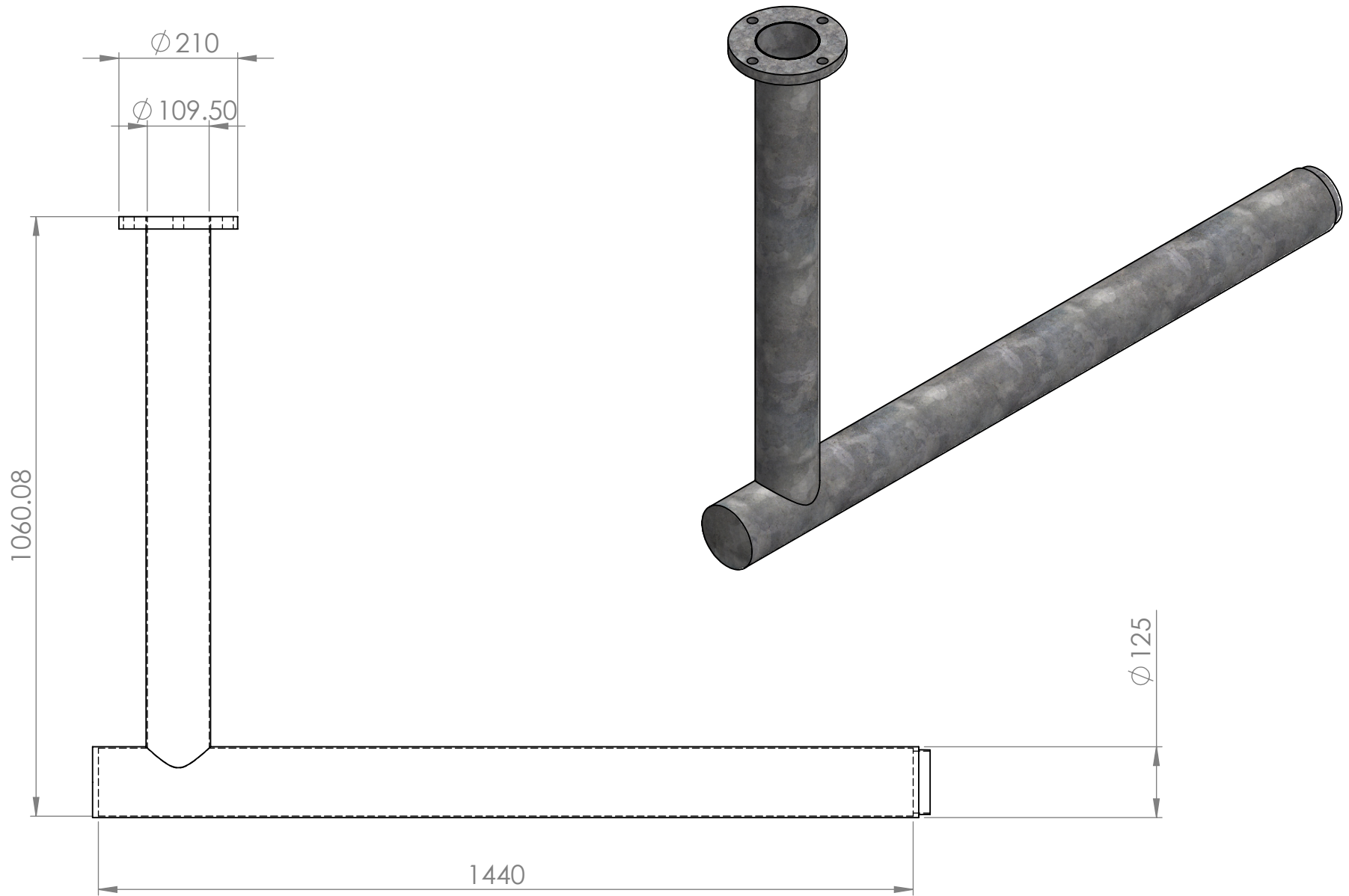
Keterangan :

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 SURABAYA**

PIPA TEKAN 8" GALVANIS

Gambar L3.22

A4



Skala : 1 : 10  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

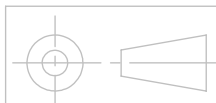
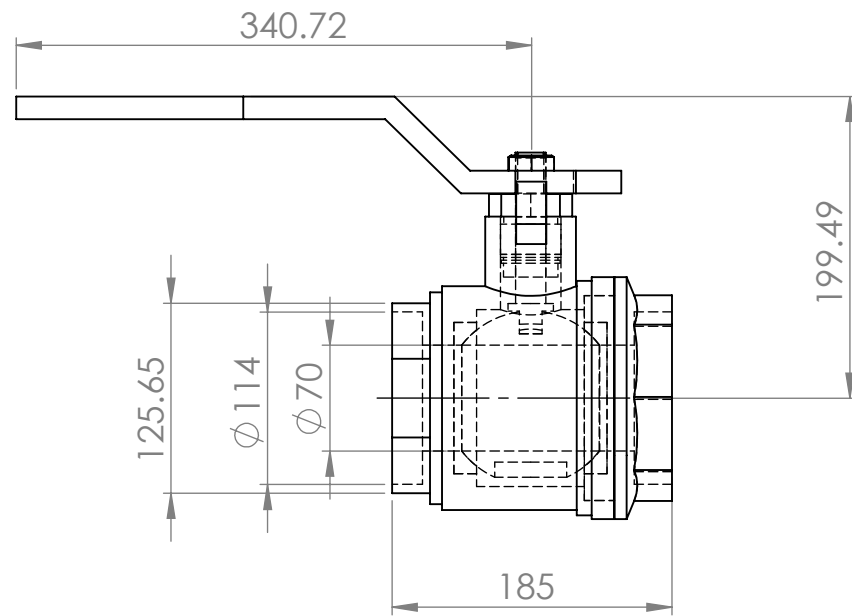
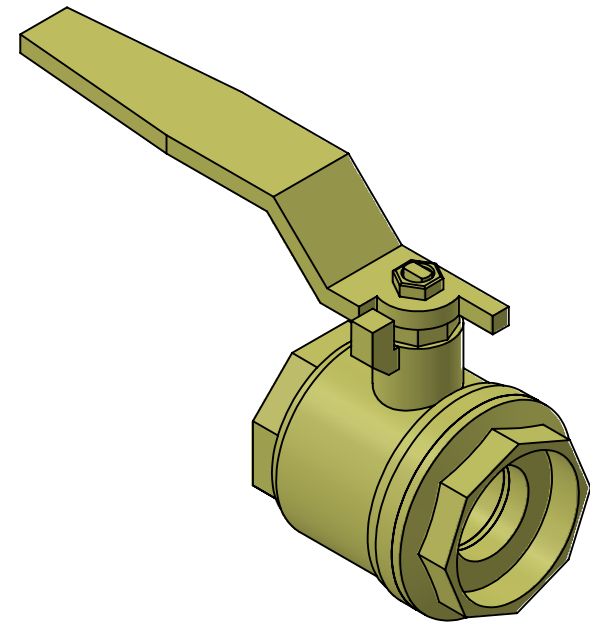
Keterangan :

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 SURABAYA**

PIPA COOLING TOWER 4"

Gambar L3.23

A4



Skala : 1 : 5	Digambar : Juhan Budi U
Satuan : mm	Fakultas : Teknik Mesin
Tanggal : 11-01-2019	Diperiksa : Ir. Anastas R, MT.

Keterangan :

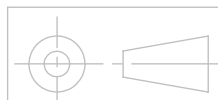
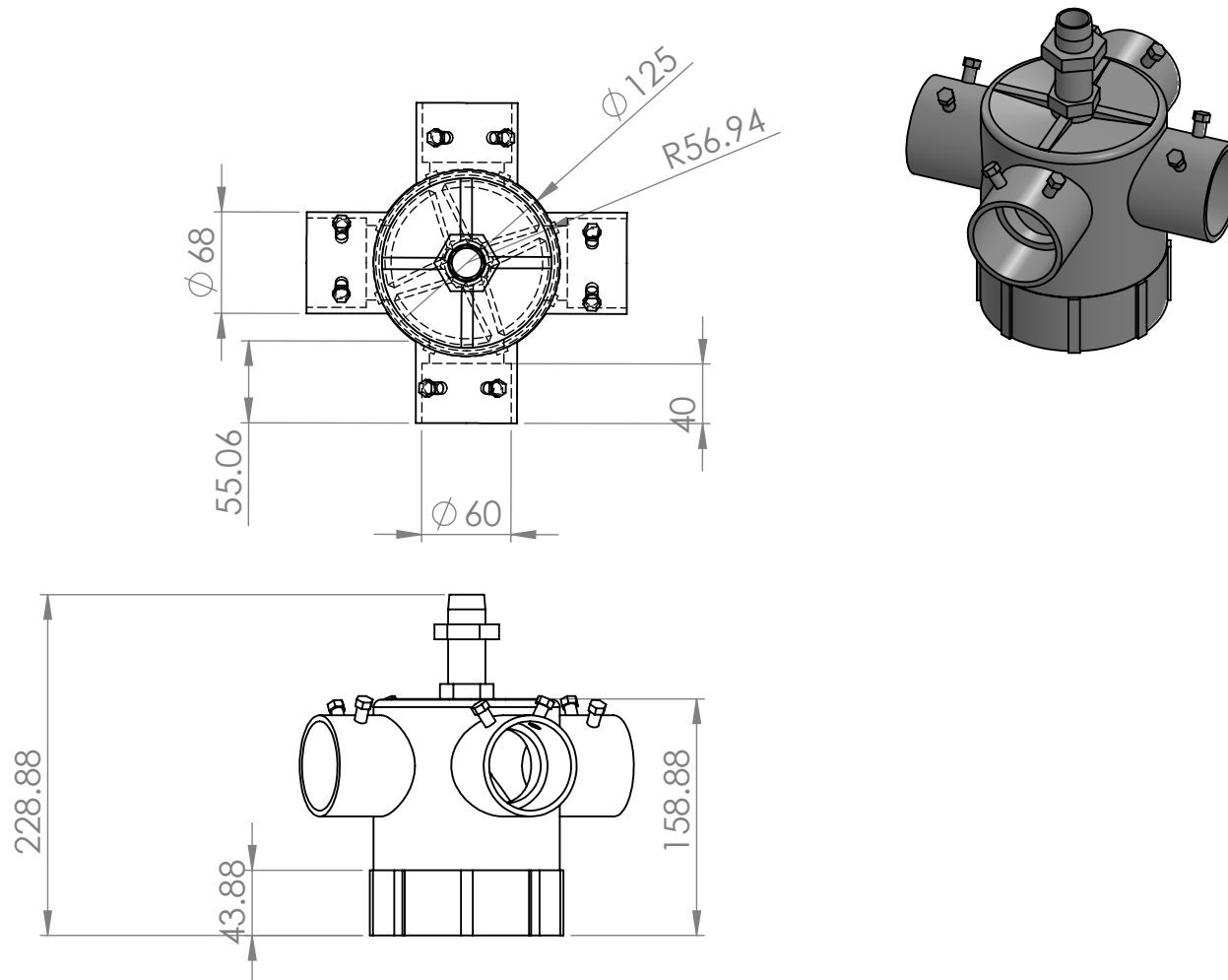
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BALL VALVE 4"

Gambar L.3.15

A4





Skala : 1 : 5  
 Satuan : mm  
 Tanggal : 11-01-2019

Digambar : Juhan Budi U  
 Fakultas : Teknik Mesin  
 Diperiksa : Ir. Anastas R, MT.

Keterangan :

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SPRINKLER HEAD 4" TO 2"

Gambar L3.14

A4