भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS

Doc. No. : PRTD/AR/PF:03	Issue No. : 1	Issue Date : 28 Apr 2020	Report of Action Research

1.	**Action Research Project No.** *(as assigned by PRTD)*	*AR/0084*
2.	**Title of the Action Research Project**	*Designing of Automatic Cupel & Sample Feeder for Cupellation Furnace in RAL*
3.	**Name & Designation of Officer**	*Arvind Prakash Dhar Dwivedi, Scientist E & Head (SROL)*
4.	**Deptt./BO/RO & Place of Posting**	*Southern Regional Office Laboratory (SROL), Chennai*
5.	**Date of Approval of the Project**	*01 July 2020*
6.	**Objective of the Project**	*1. To design equipment through which, Cupels & Samples can be fed in furnace with minimum human involvement.* *2. To identify the suitable material of construction for Automatic feeder.*
7.	**Report of Action Research Activities**	*Attached*
8.	**Conclusion & Recommendations**	➢ *The Automatic Cupel & Sample Feeder for Cupellation Furnace in RAL may be got fabricated by RAL of BIS as per the design/drawing given.* ➢ *This automatic feeder would ensure safety of testing personnel.* ➢ *It may also enhance output in terms of number of samples tested.*
9.	**Any other relevant information**	*No*

(A.P.D. Dwivedi)
Sc. E & Head (SROL)

<u>Sc. G & DDG (Labs)</u>

Sc. G & DDG (PRT)

TABLE OF CONTENTS WITH LIST OF FIGURES AND TABLES

1. INTRODUCTION

Bureau of Indian Standards is operating Hallmarking scheme in which Registration is granted to the jewellers by BIS under Hallmarking Scheme. The BIS certified jewellers can get their jewellery hallmarked from any of the BIS recognized Assaying and Hallmarking Centres.

Samples of Hallmarked Gold Jewellries drawn by Conformity Assessment Department of BIS is tested in Referral Assay Laboratories of BIS.

Various steps involved in testing of Gold samples as per IS 1417:2016 & IS 1418:2009 are as follows:

1. Checking of purity through XRF-Spectrophotometer

2. Fire assay consisting of :

   (i) Cupellation
   (ii) Annealing
   (iii) Parting

Out of above three processes mentioned at Sr. No. 2, **Cupellation**, is the most important and critical process and requires adequate control and proper safety during feeding of cuples and Assay samples into cupellation furnace as temperature of cupellation furnace is maintained at around 1100 ^oC.

The process of cupellation involves following steps:

(i) Maintaining of Cupellation furnace at 1100 ^oC **(Figure-1)**.

(ii) Placing Magnesia Cuples into Cupellation furnace manually with help of tongue. Four cupels are placed one by one and adjusted in the furnace so that there is no gap between four cuples **(Figure-2)**.

(iii) Preheating of cuples to at least 1100 ^{o} C **(Figure-3)**

(iv) All the four cuples are having six cavities so that total 24 cavities are available for placing samples. Each sample (Assay sample) is tested in duplicate (10 x 2) and 4 proof assay samples of proof gold are also placed in the cuples **(Figure-4)**. So total 10 samples can be tested at a time at present.

(v) Placing the Assay and the Proof Assay samples one by one, in cavities in Magnesia cupels which have been preheated to 1100°C in the cupellation furnace **(Figure-5)**.

(vi) Continue heating at cupellation furnace maintained at 1050 ^{o}C – 1100 °C, until this stage is completed (about 25 min) under oxidizing conditions.

(vii) Removing the cupels from the furnace in the same manner in which it was placed in the furnace. Allowing the precious metal buttons to cool down before lifting them from the cupels with the assay pliers.

From the above process, it may be seen that testing personnel are exposed to high temperature of 1050 ^{o}C – 1100 °C and also cuples & Assay samples are placed manually in the furnace with the help of tongue.

Placing Cupels, Assay and the Proof Assay samples requires some time, and during this period the testing personnel are exposed to high temperature and toxic fumes coming out of the cupellation furnace.

This also limits the number of cuples which can be placed in to the cupellation furnace as for placing more number of samples (more than four cuples), more time is required and it results result in considerable drop of temperature. As per the present practice maximum 10 samples are tested at a time by placing four cuples in the cupellation furnace.

Therefore, a mechanism with automatic feeding of all cupels at a time and simultaneous placing of all Assay and the Proof Assay samples will considerably reduce duration of exposure of testing personnel to high temperature and toxic fumes. Also, with the provision of placing all Assay and the Proof Assay samples simultaneously, more number of cuples and consequently more number of samples can be placed in the cupellation furnace in short time without considerable drop in temperature, as door of the furnace will be open for short duration.

With automatic feeding arrangement, there will be following three major advantages:

(i) Safety of testing personnel;

(ii) Ease of operation;

(iii) Enhanced testing capacity.

With above objective, equipment “**Automatic Cupel & Sample Feeder for Cupellation Furnace in RAL”** has been designed. While designing the equipment, it has also been considered to select suitable material which can with stand the required temperature and easy for welding.

Figure 1: Magnesia Cupels

Figure 2: Feeding of Cupels in Cupellation Furnace

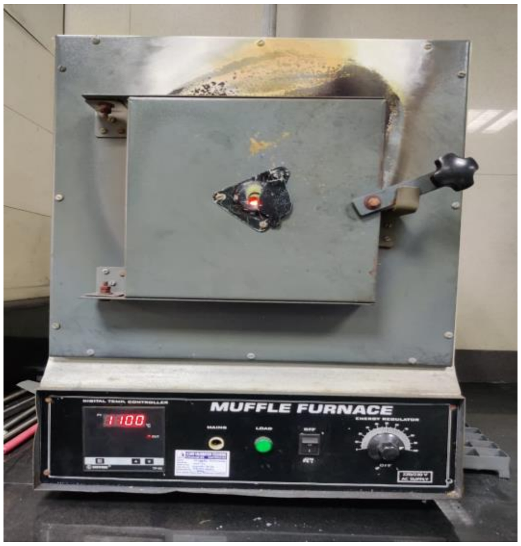

Figure 3: Pre-heating of Cuples in Cupellation Furnace

Figure 4: Assay and the Proof Assay samples for feeding in to Cupellation furnace

Figure 5: Assay and the Proof Assay samples feeding in Cupellation furnace

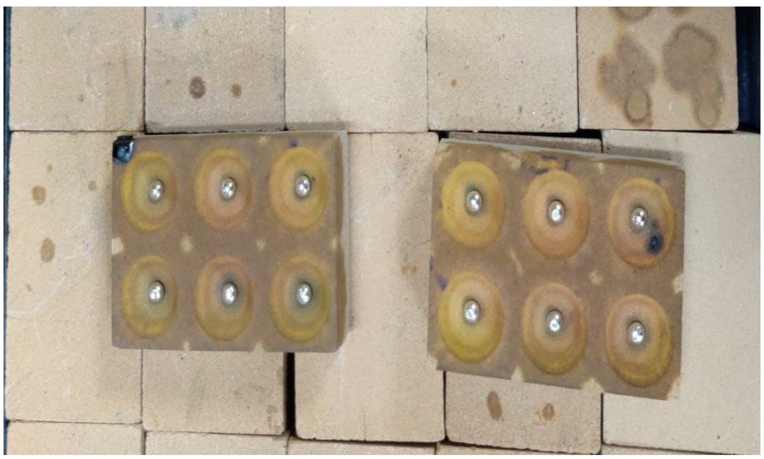

Figure 6: Completion of Cupellation process

2. REVIEW OF LITERATURE (BACKGROUND RESEARCH/LITERATURE SURVEY/ANY OTHER MEANS ETC)

For designing the equipment, the process of testing prescribed in following Indian Standards has been referred:

- IS 1417:2016 (Gold and gold alloys, jewellery/artefacts - Fineness and marking)

- IS 1418:2009 (Determination of Gold in Gold Bullion, Gold Alloys and Gold Jewellery/Artifacts Cupellation (Fire Assay) Method) has been referred.

For deciding the suitable material for construction of the feeding mechanism, various articles available on internet has been referred.

3. METHODS & MATERIALS, DATA, DETAILS OF FIELD VISITS FOR STUDIES & RESEARCH ETC.

As an Auditor for Assaying and Hallmarking, approximately 15 hallmarking centres have already been visited and testing witnessed.

During the visits to BIS Central Laboratory testing procedure adopted by Central Laboratory has been observed.

SROL is having, Referral Assay Laboratory and engaged in regular testing of Gold samples. Detailed discussion has been held with testing personnel regarding various aspects of testing.

Witnessing of testing on various occasions and discussion held with testing personnel enabled to understand the difficulties faced by the testing personnel during cupellation process and to find suitable method to reduce the hazard to which testing personnel are exposed and also to find ways to explore the possibility to enhance the testing capacity.

Earlier trials were made by RAL, SROL utilizing feeder for simultaneous feeding of 12 Assay and the Proof Assay samples (**Figure 7).**

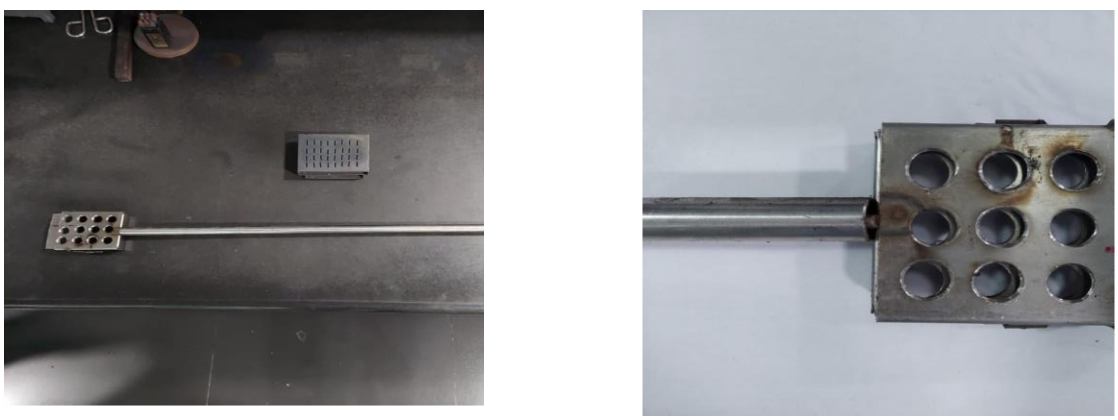

Figure 7: Feeder for simultaneous feeding of 12 Assay and the Proof Assay samples

Also, big feeders are also available for simultaneous feeding of multiple samples. Please see **Figure 8**.

Figure 8: Big feeder

During, this project effort was made to use big cuples in place of small cuples so that one cupel can be used in place of four cuples (**Figure 9).** But handling big cuples with tongs was found difficult especially at the time of removing it from heated furnace.

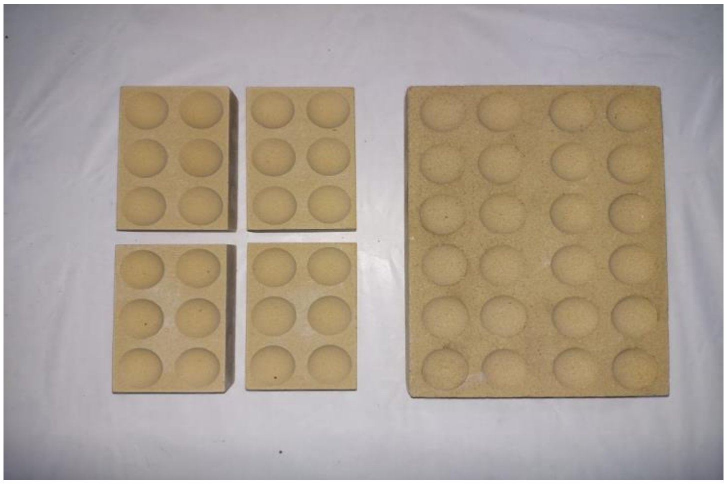

Figure 9: Big Cupel

Also to keep cuples in compact form, tray was used (**Figure 10).**

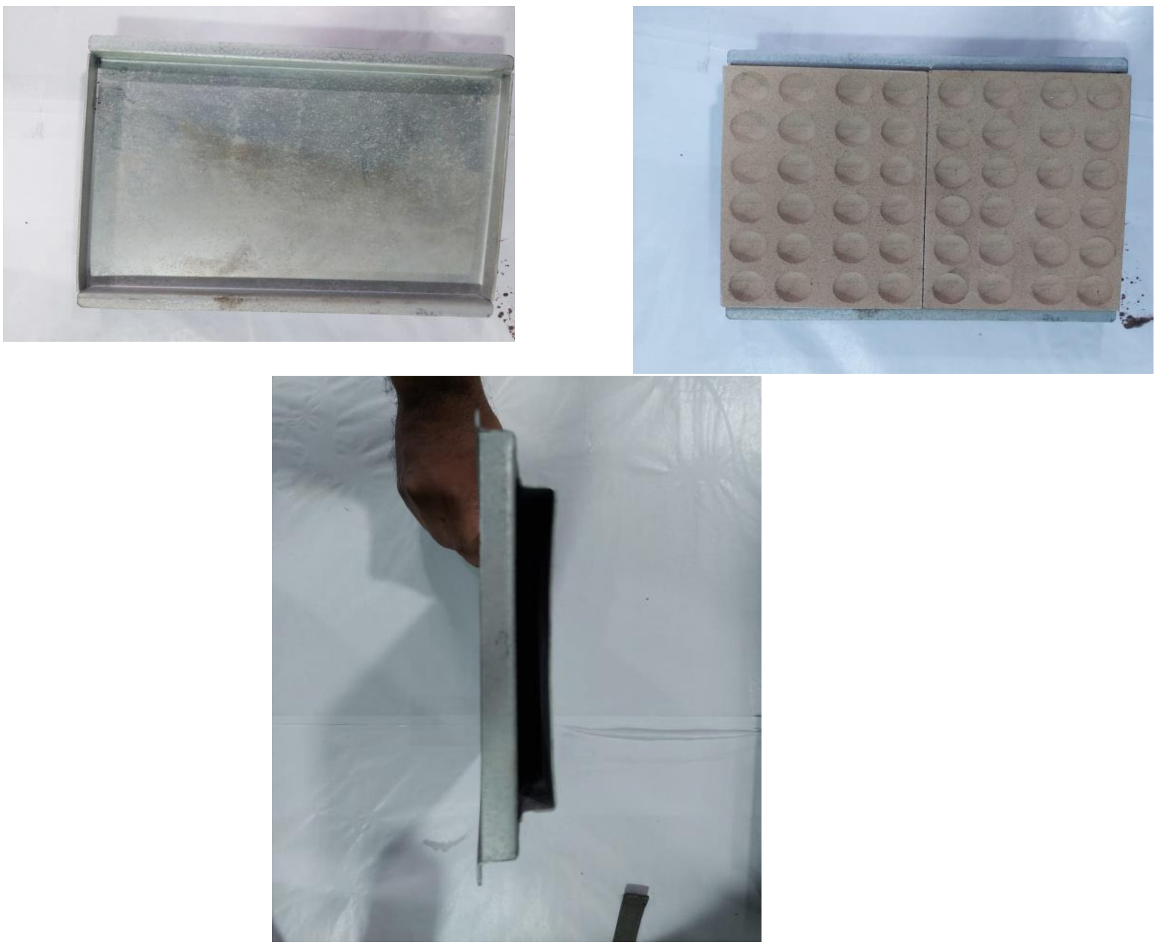

Figure 10 : Cupel Tray

Also, to avoid rolling out of Assay and the Proof Assay samples, which are in ball shape from available feeders, different design of feeder with 48 slots was tried (**Figure 11).**

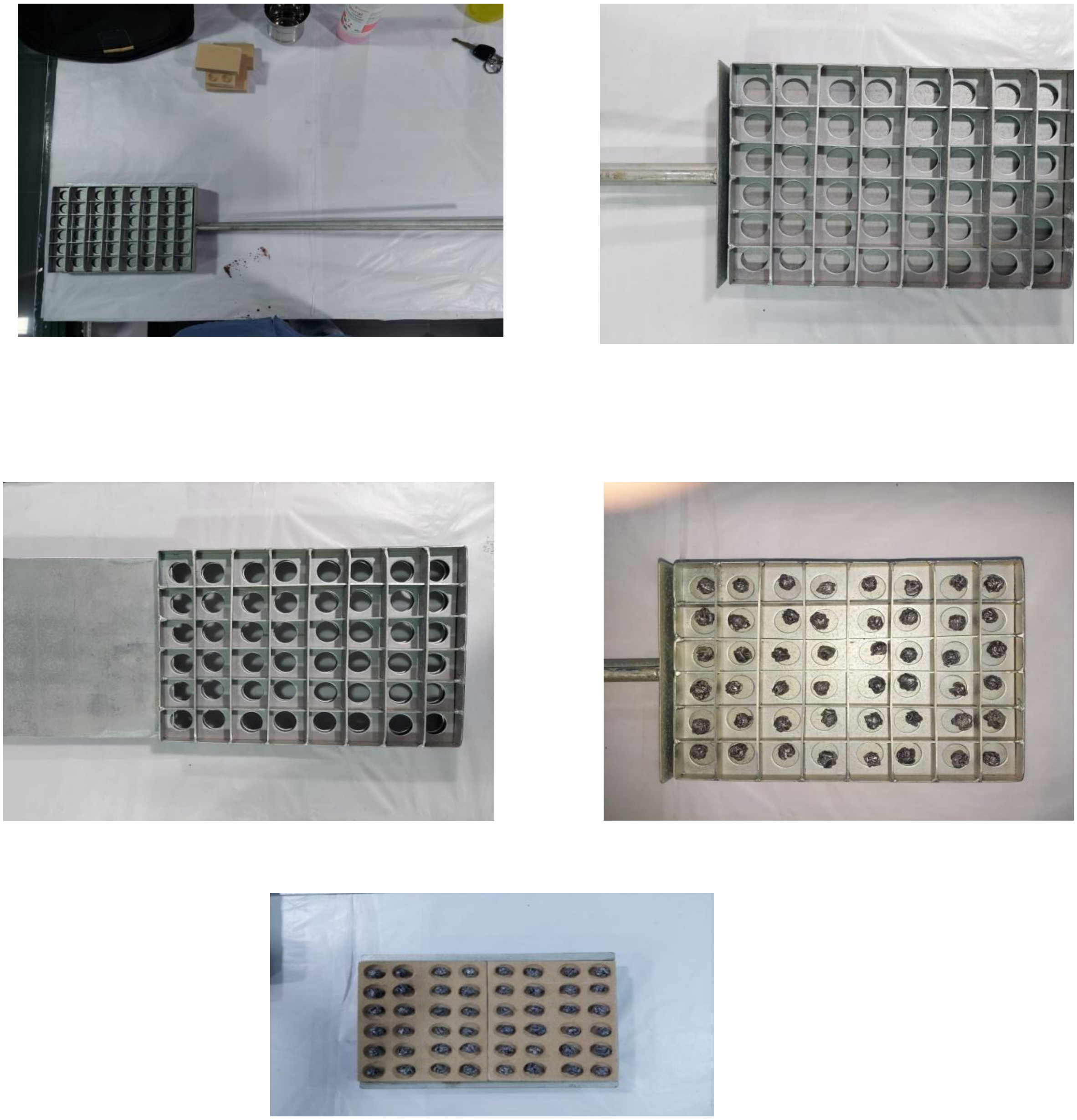

Figure 11 : Feeder with 48 slots

Constraints/Challenges observed during these trials:

(i) With feeder of 12 holes/cavity

- Aligning Sample feeder holes with cupels cavity, while cupels are placed in Furnace at elevated temperature at around 1100 ^{o}C.

- Manually feeding and aligning is not possible

  - 4 Cuples cannot be placed in compact manner
  - Furnace at high temperature
  - Low visibility
  - Considerable drop in furnace temperature
  - Rolling out of sample balls from the feeder

(ii) With feeder of 48 holes/cavity

- Aligning Sample feeder holes with cupels cavity, while cupels are placed in Furnace at elevated temperature at around 1100 ^{o}C.

- Manually feeding and aligning is not possible

  - Feeder is heavy
  - Furnace at high temperature
  - Low visibility

Therefore it was felt that for feeding of cupels and samples, some ***Mechanical Mechanism*** is needed for perfect alignment.

Various mechanisms being used for feeding cuples were searched in internet and few are given at **Figure 12**.

Based on the above, the equipment has been designed.

Figure 12 : Various Feeding Mechanism

4. RESULTS & ANALYSIS

4.1 AIM of the ARP

The aim of the Action Research Project is to address following issues:

(i) Manual feeding of cupels with tongue, one by one in to the cupellation furnace maintained at around 1100 ^{o}C

(ii) Manual feeding of Assay and the Proof Assay samples one by one in to Cupellation furnace maintained at around 1100 ^{o}C

(iii) Limitation of number of cuples which can be placed in to the cupellation furnace as for placing more number of cuples (more than four cuples) and subsequently more number of samples, more time is required and it results in considerable drop of temperature and thus adversely affecting the result.

During the process (i) & (ii), testing personnel are exposed to high temperature and toxic fumes for long duration.

4.2 Analysis

The exposure time can be reduced by following means:

(i) Providing Automatic mechanism for simultaneous feeding of all cuples in the furnace in one go.

(ii) Providing Automatic mechanism for simultaneous feeding of all Assay and the Proof Assay samples in to Cupellation furnace in one go.

The above two arrangement will reduce the time duration for which furnace door is open thereby considerably reducing the duration of exposure and also reduce the temperature drop of the furnace. With automatic feeding mechanism since time duration of opening of furnace door is less, more number of cuples can be placed in the furnace and consequently more samples may be tested at a time.

Considering the size of the existing cupellation furnace, 8 cuples can be accommodated in the furnace. These 8 cuples will have total 48 cavities in which 20 samples in duplicate

(20 x 2) and 8 Proof Assay samples may be placed. Thus total 20 samples may be tested at a time instead of 10 samples as being tested presently **(Figure 13)**.

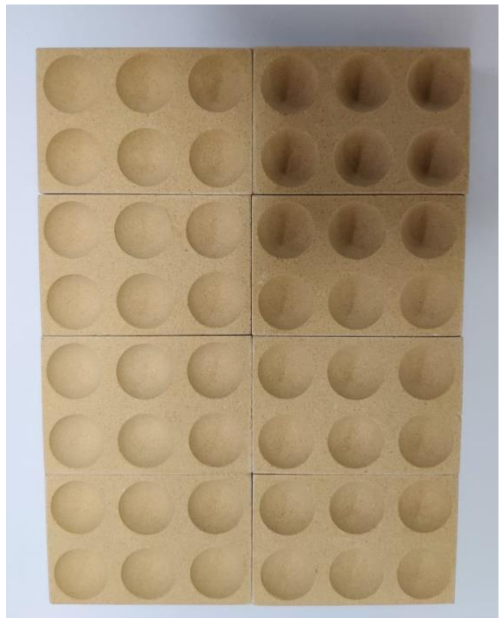

Figure 13: Cuples 8 Nos layout

4.3 Design of the equipment

Details of the component are placed at Table 1, Page 18.

Two-dimensional drawing of different components along with dimensions of the Automatic Cupel and sample feeder are given at **Page 19 to 55**.

Three Dimensional Drawings of the mechanism is given at **Page 56 to 60.**

AUTOMATIC CUPEL AND SAMPLE FEEDER FOR CUPELLATION FURNACE IN RAL			
Drawing No	**Description**	**Material / Model**	**Qty in Number**
BIS/SROL/AR-0084/00	Assembly		
BIS/SROL/AR-0084/01	Spur Gear	EN353	1
BIS/SROL/AR-0084/02	Rack	EN353	1
BIS/SROL/AR-0084/03	Rack Support Plate	MS	1
BIS/SROL/AR-0084/04	"L" Clamp for DC Motor	MS	1
BIS/SROL/AR-0084/05	DC Gear Motor	24V DC	1
BIS/SROL/AR-0084/06	LM Bearing Mounting Plate(Top)	Aluminium	1
BIS/SROL/AR-0084/07	LM Bearing	SC25UU	8
BIS/SROL/AR-0084/08	LM Shaft End Support	SK-25	8
BIS/SROL/AR-0084/09	Ball Screw Nut Housing	Aluminium	2
BIS/SROL/AR-0084/10	Ball Screw End Support	BF 15	4
BIS/SROL/AR-0084/11	Zero Backlash Oldham coupling	SOH - 43C	2
BIS/SROL/AR-0084/12	Stepper Motor Mounting Plate	Aluminium	2
BIS/SROL/AR-0084/13	Hybrid Stepper Motor	PSM57HS2A106-2P	2
BIS/SROL/AR-0084/14	Ball Screw Nut	FSU 2005-4	2
BIS/SROL/AR-0084/15	Ball Screw	FSU 2005-4	2
BIS/SROL/AR-0084/16	LM Shaft - 25Ø	SUJ2	4
BIS/SROL/AR-0084/17	Base Plate - 1	Aluminium	1
BIS/SROL/AR-0084/18	Vertical Plate	Aluminium	6
BIS/SROL/AR-0084/19	LM Bearing Mounting Plate(Bottom)	Aluminium	1
BIS/SROL/AR-0084/20	Base Plate - 2	Aluminium	1
BIS/SROL/AR-0084/21	LM Shaft - 30Ø	SUJ2	4
BIS/SROL/AR-0084/22	Sleeve	MS	4
BIS/SROL/AR-0084/23	Center Sleeve	MS	1
BIS/SROL/AR-0084/24	LM Bearing	LMF30UU	4
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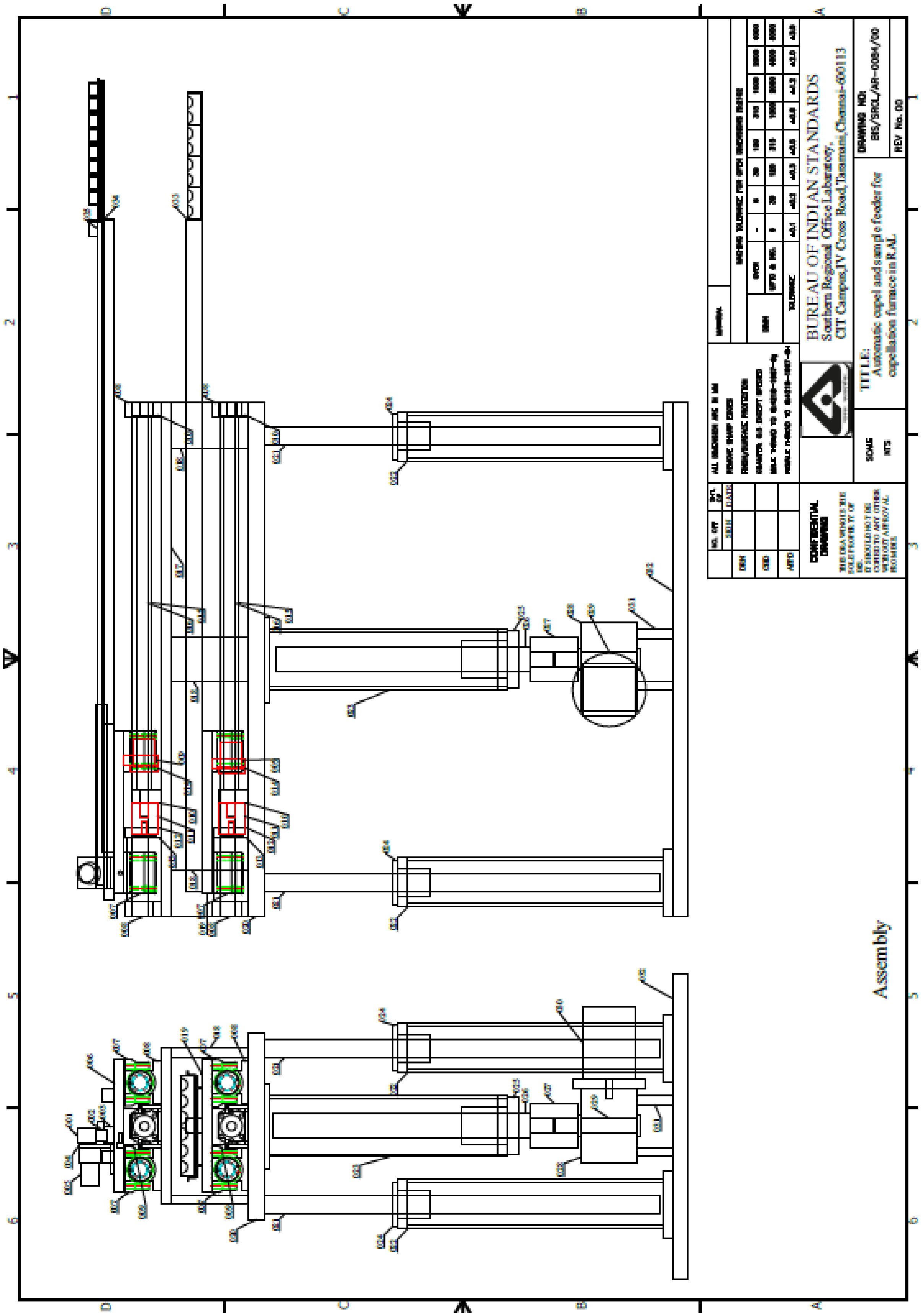
BIS/SROL/AR-0084/26	Ball screw	FSU 4010-4	1
BIS/SROL/AR-0084/27	Zero Backlash Oldham coupling	SOH-70C	1
BIS/SROL/AR-0084/28	Gear Box	TW50 80 B5	1
BIS/SROL/AR-0084/29	Center Shaft	MS	1
BIS/SROL/AR-0084/30	2 phase hybrid step motor	PSM86HS2A118-2P	1
BIS/SROL/AR-0084/31	Gear Box Base	MS	1
BIS/SROL/AR-0084/32	Base Plate (Bottom)	MS	1
BIS/SROL/AR-0084/33	Bottom Tray	Alloy C 276	1
BIS/SROL/AR-0084/34	Material Loading Tray	Alloy C 276	1
BIS/SROL/AR-0084/35	Material Holding Plate	Alloy C 276	1
BIS/SROL/AR-0084/36	Bottom Tray Loader	Alloy C 276	1

Table 1: Details of the component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BIS/SROL/AR-0084/00
REV No. 00
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NTS
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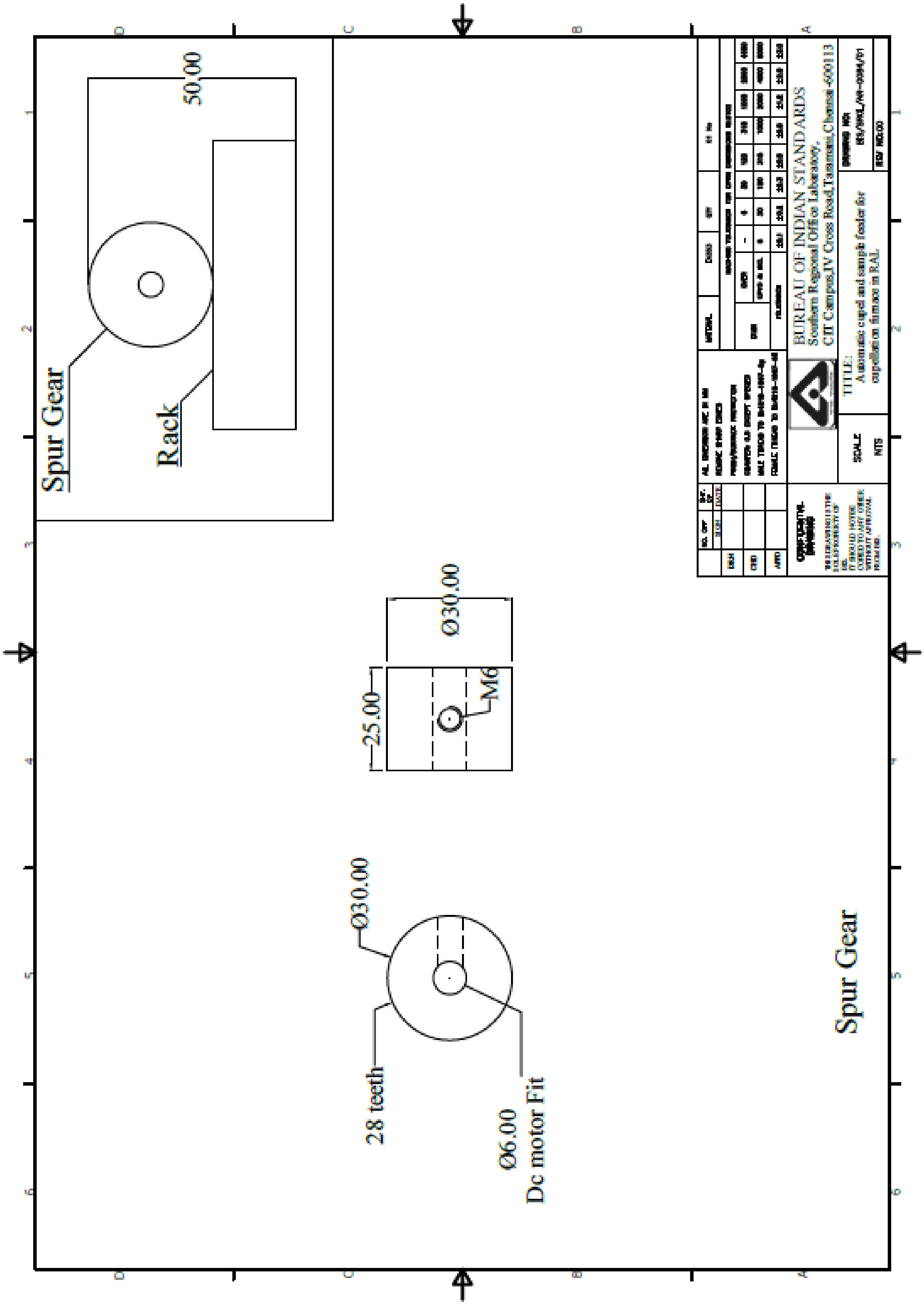
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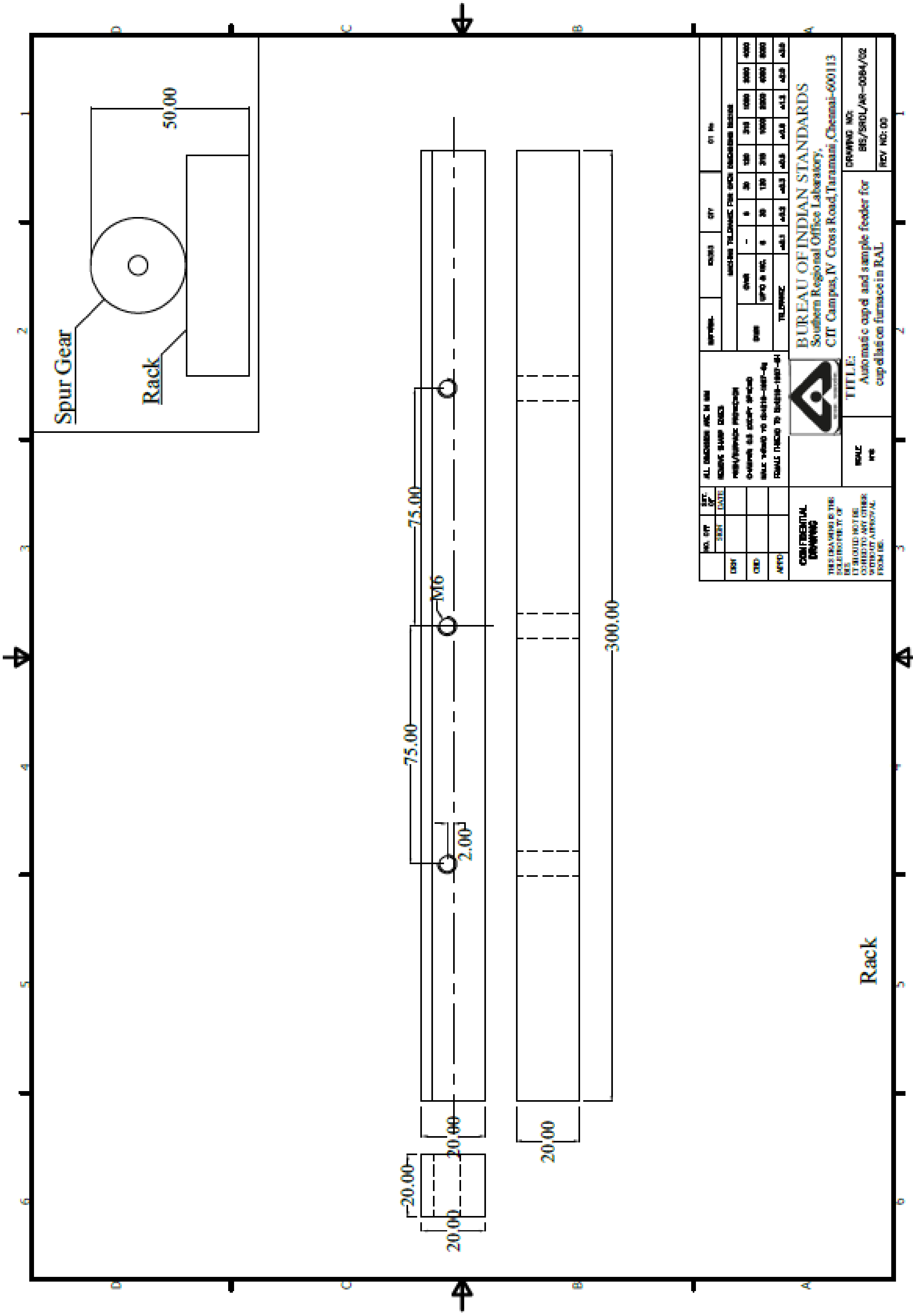

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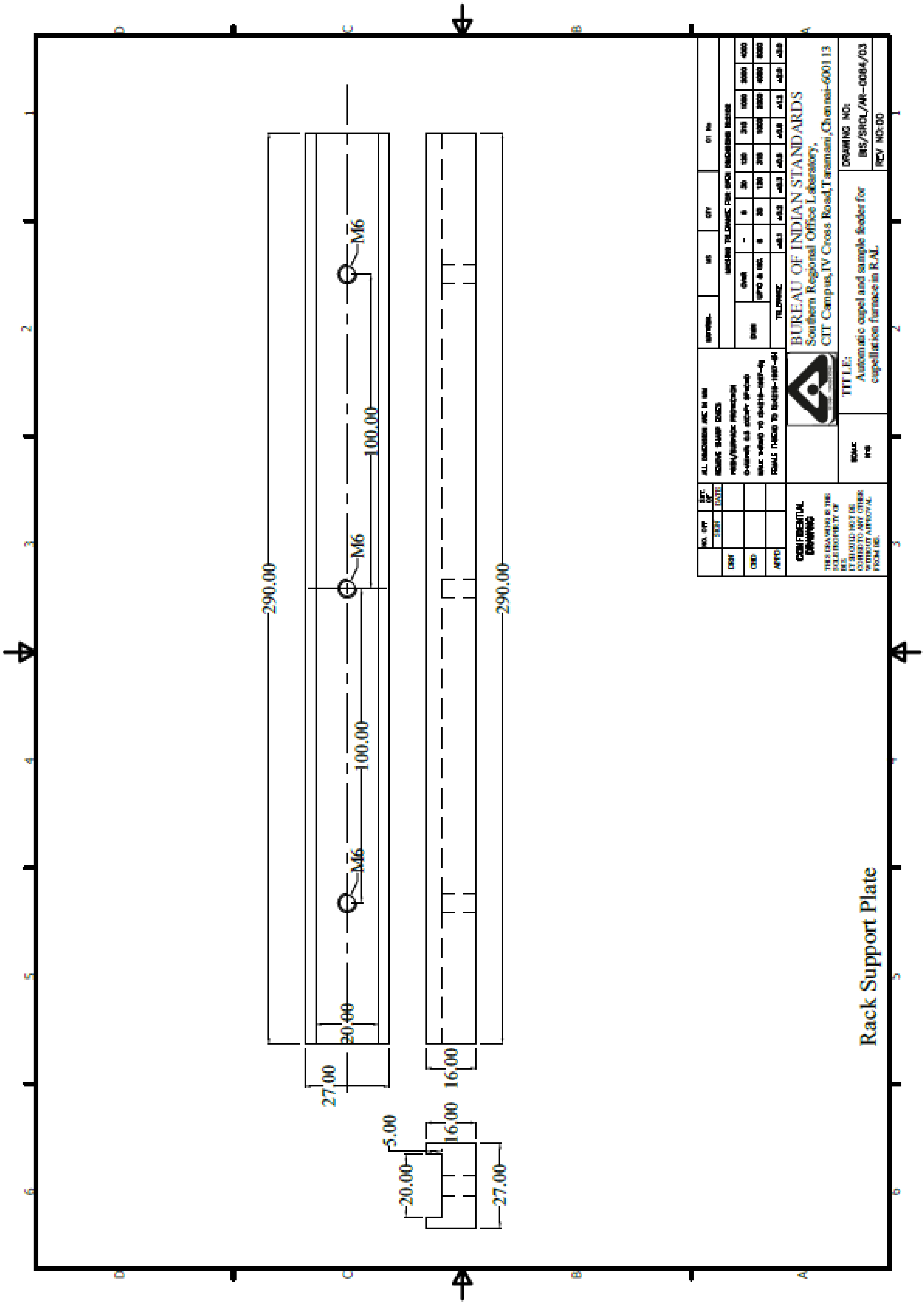
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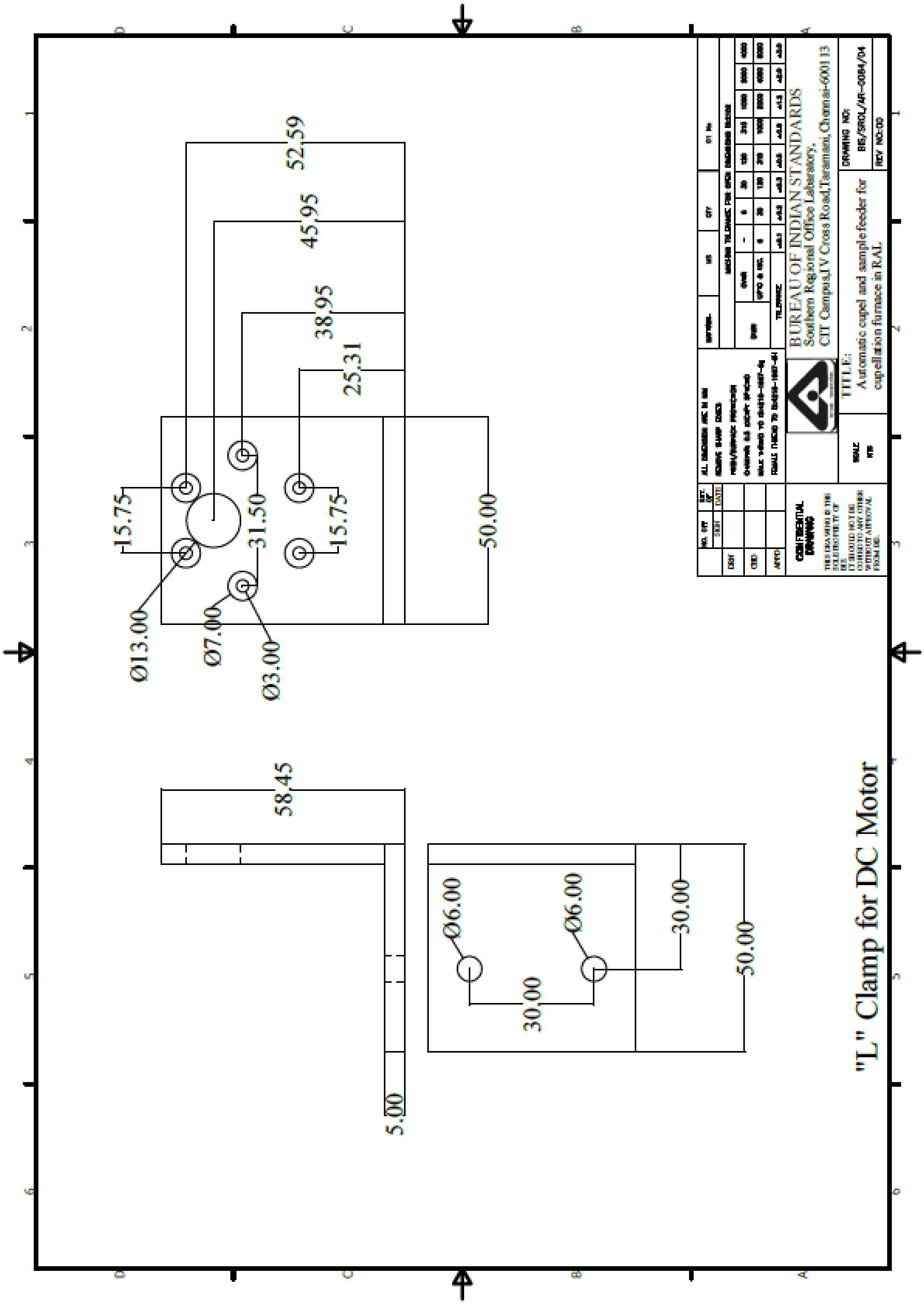
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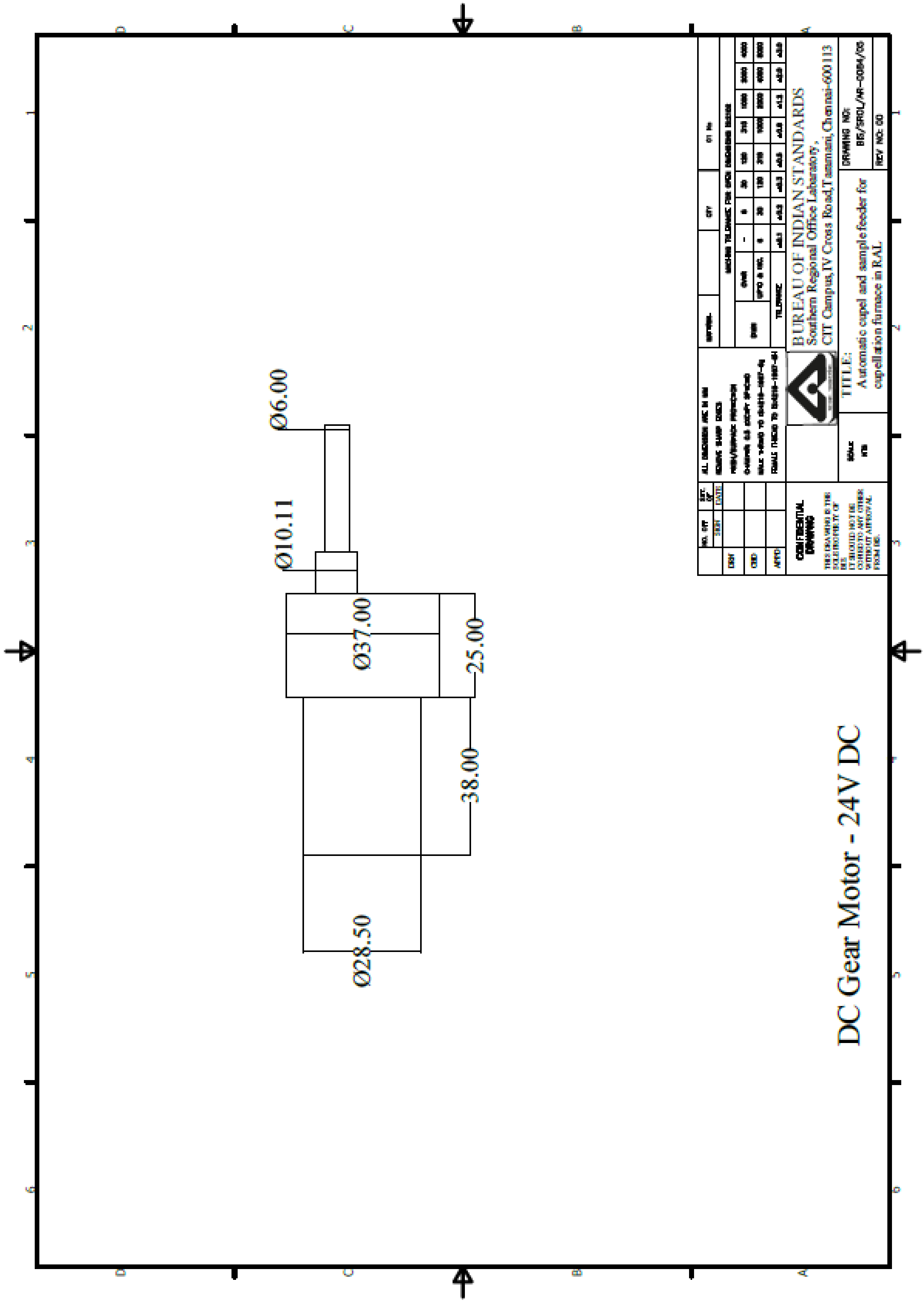
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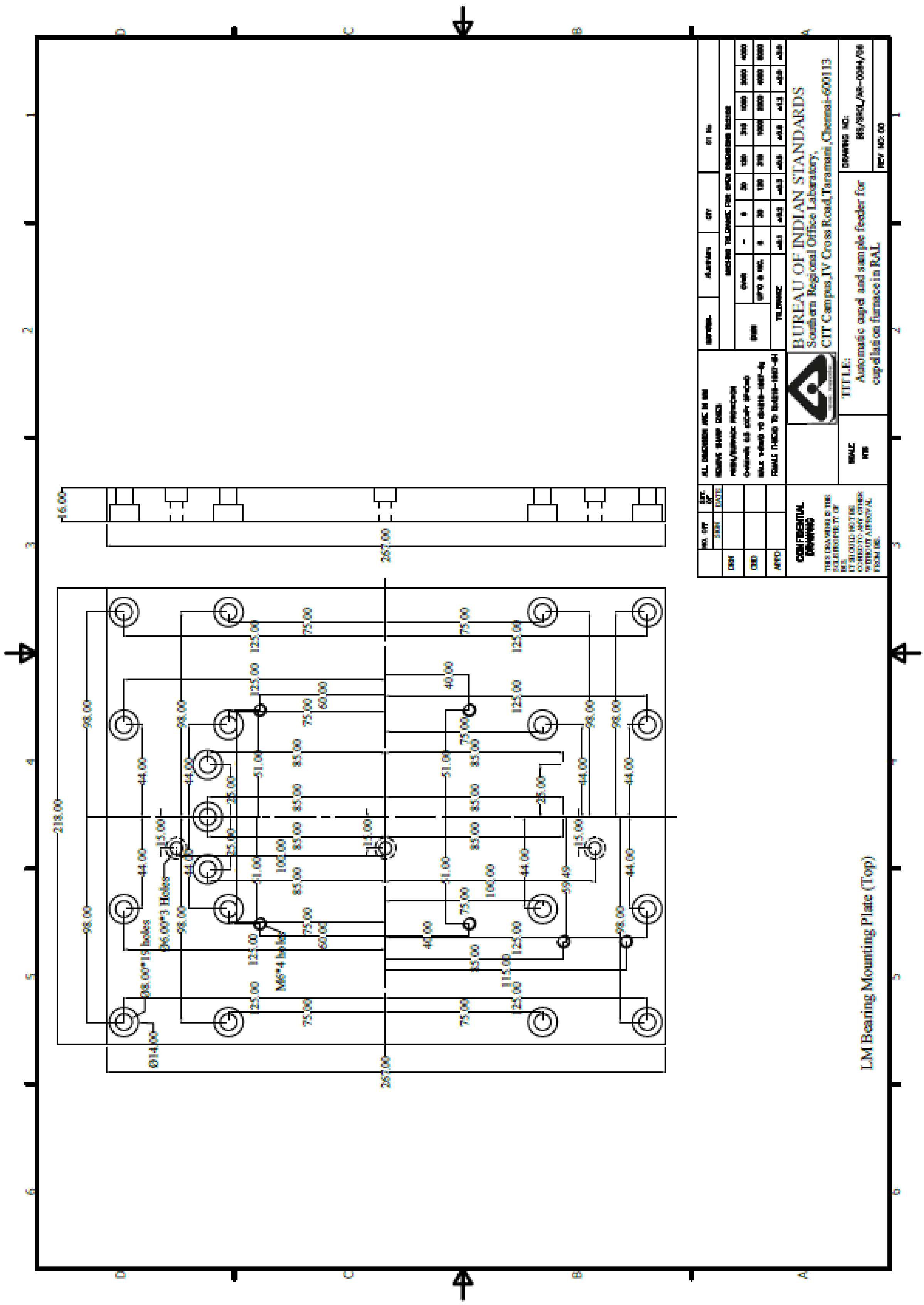
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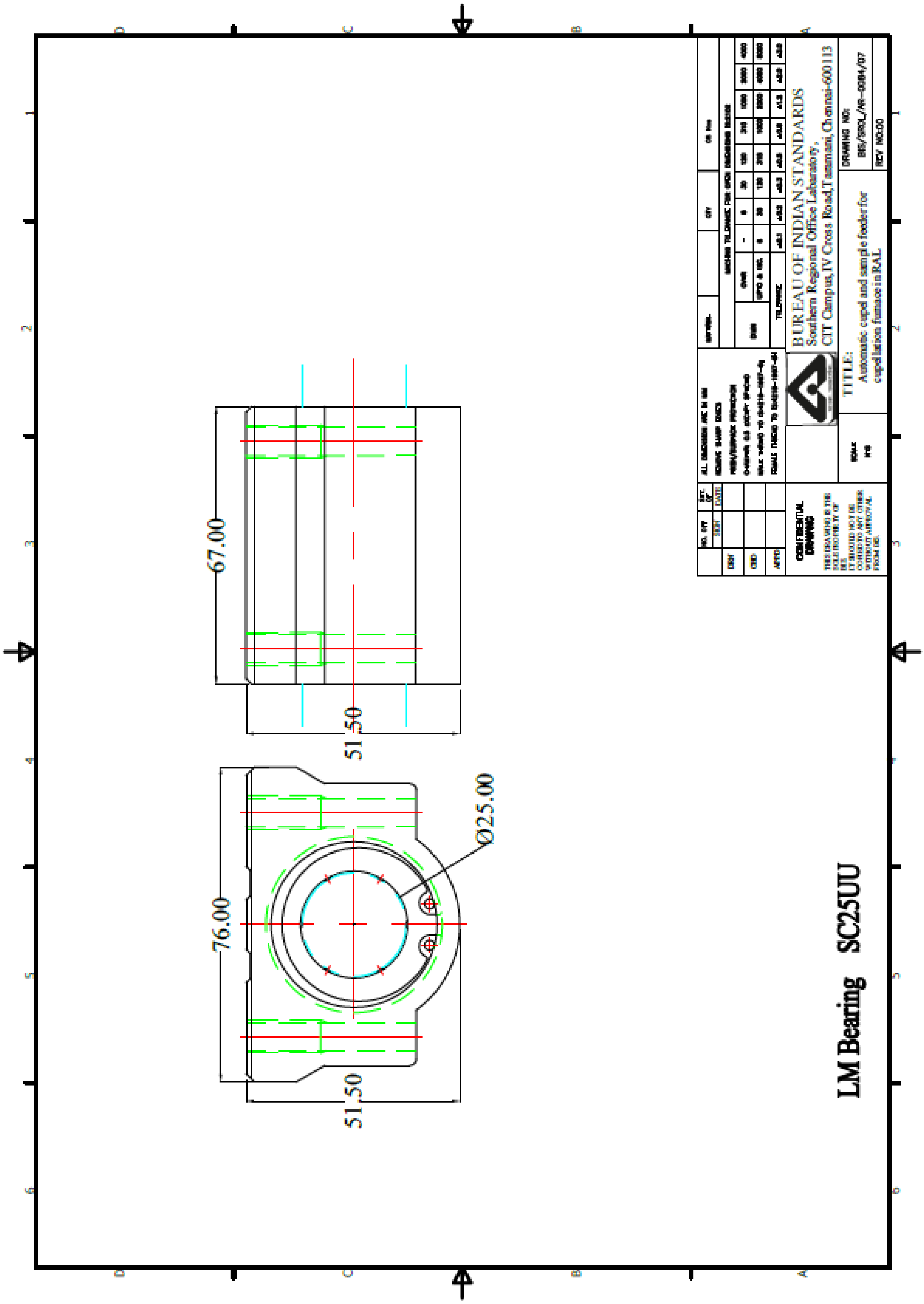
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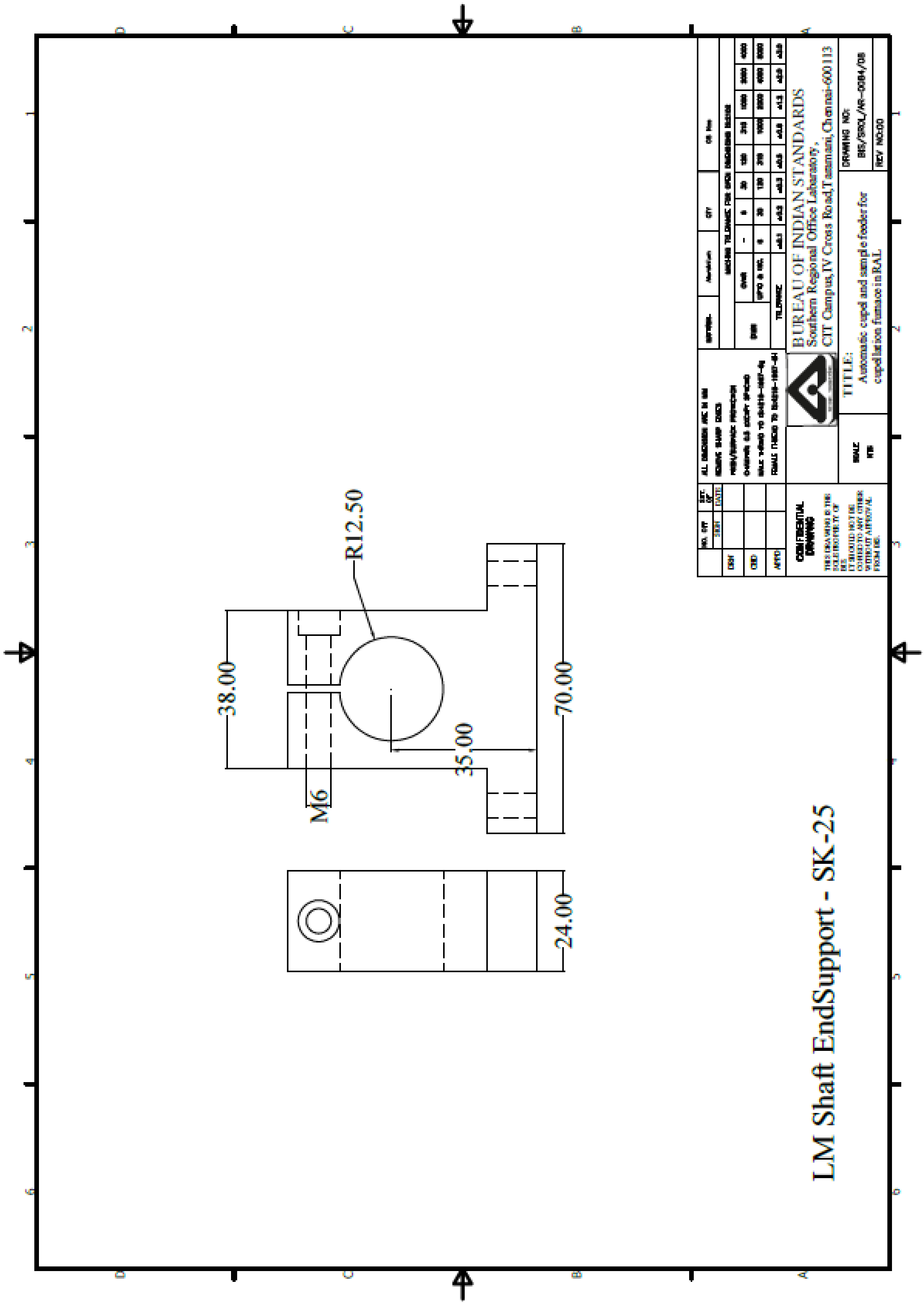
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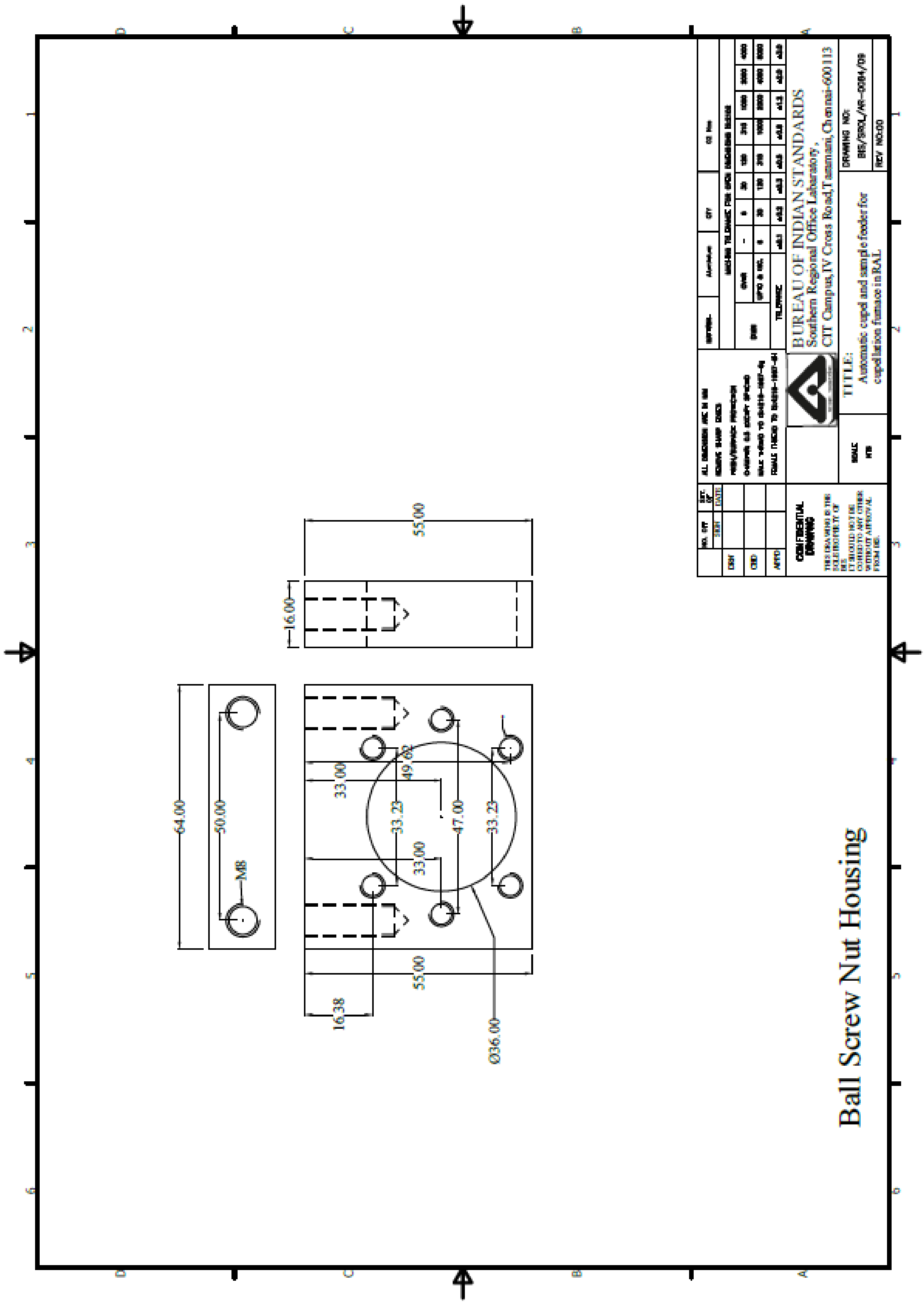
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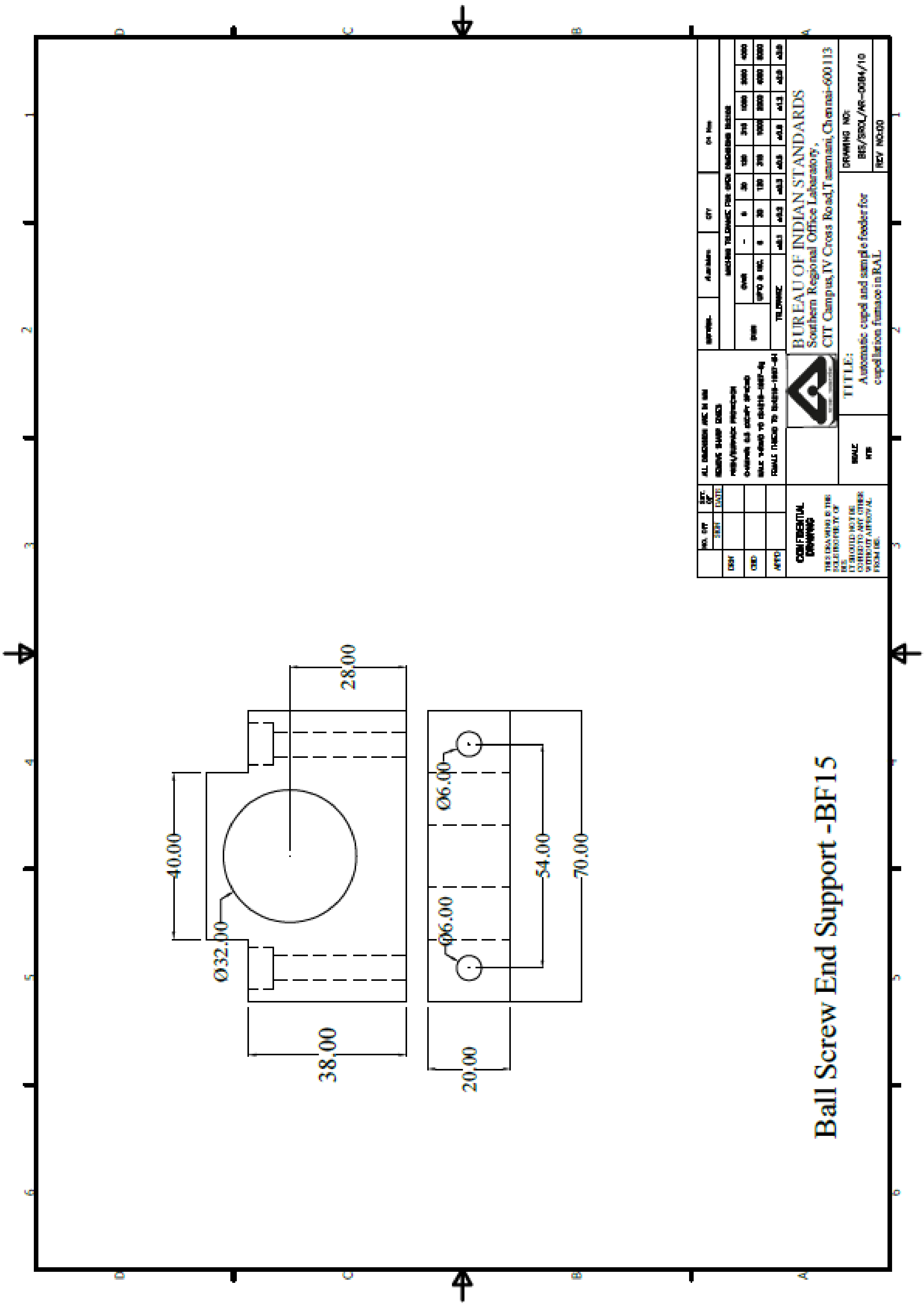
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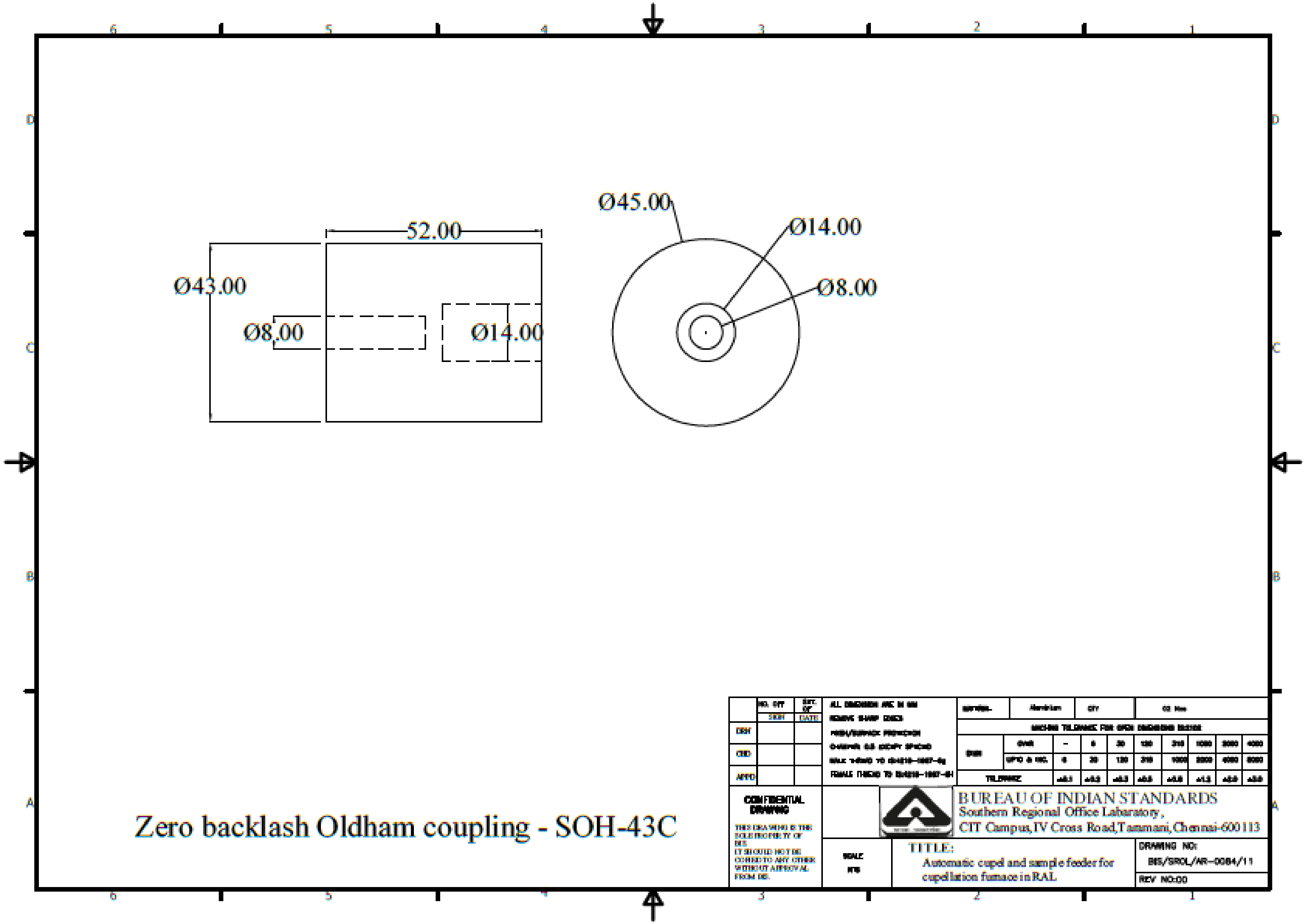

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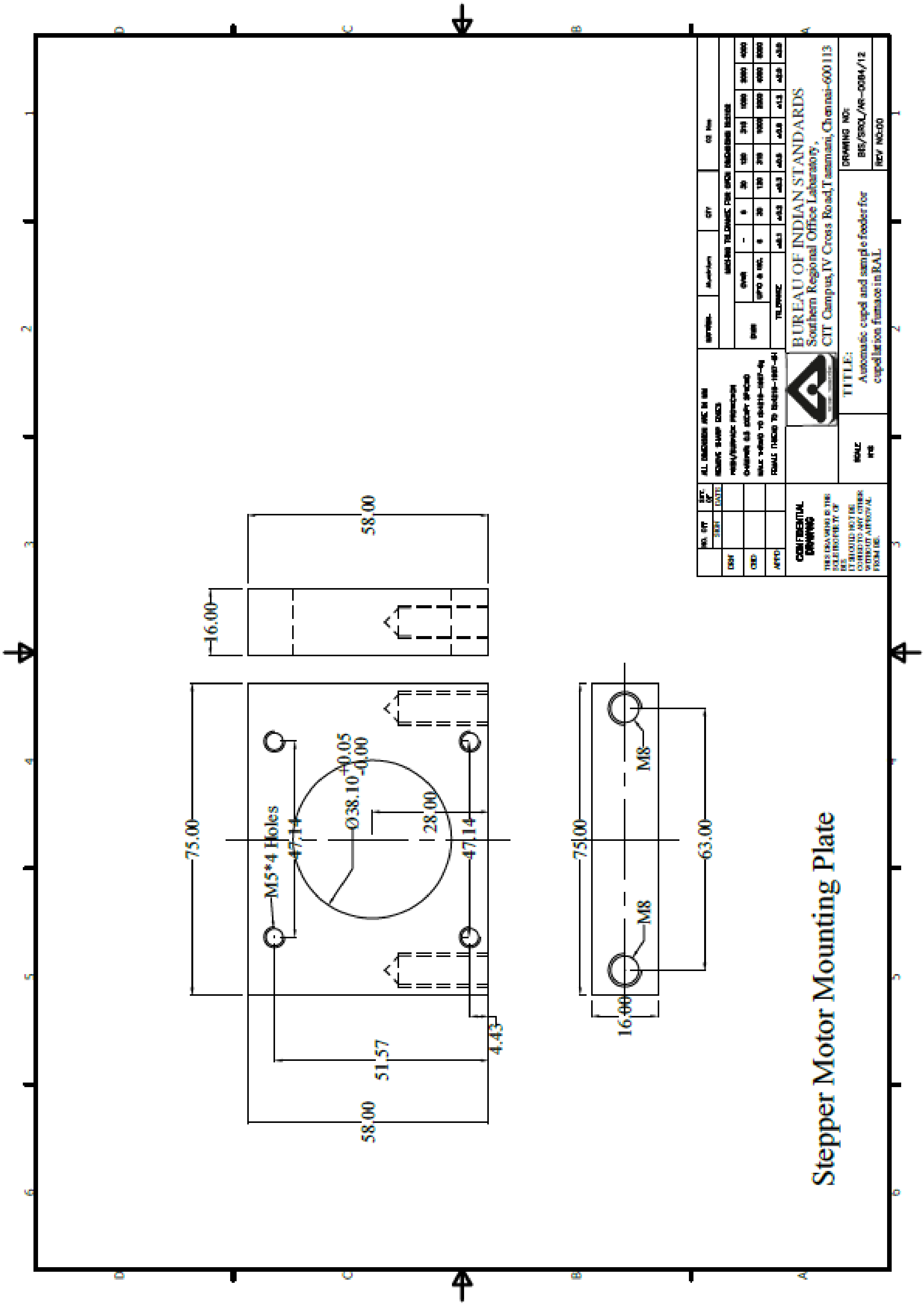
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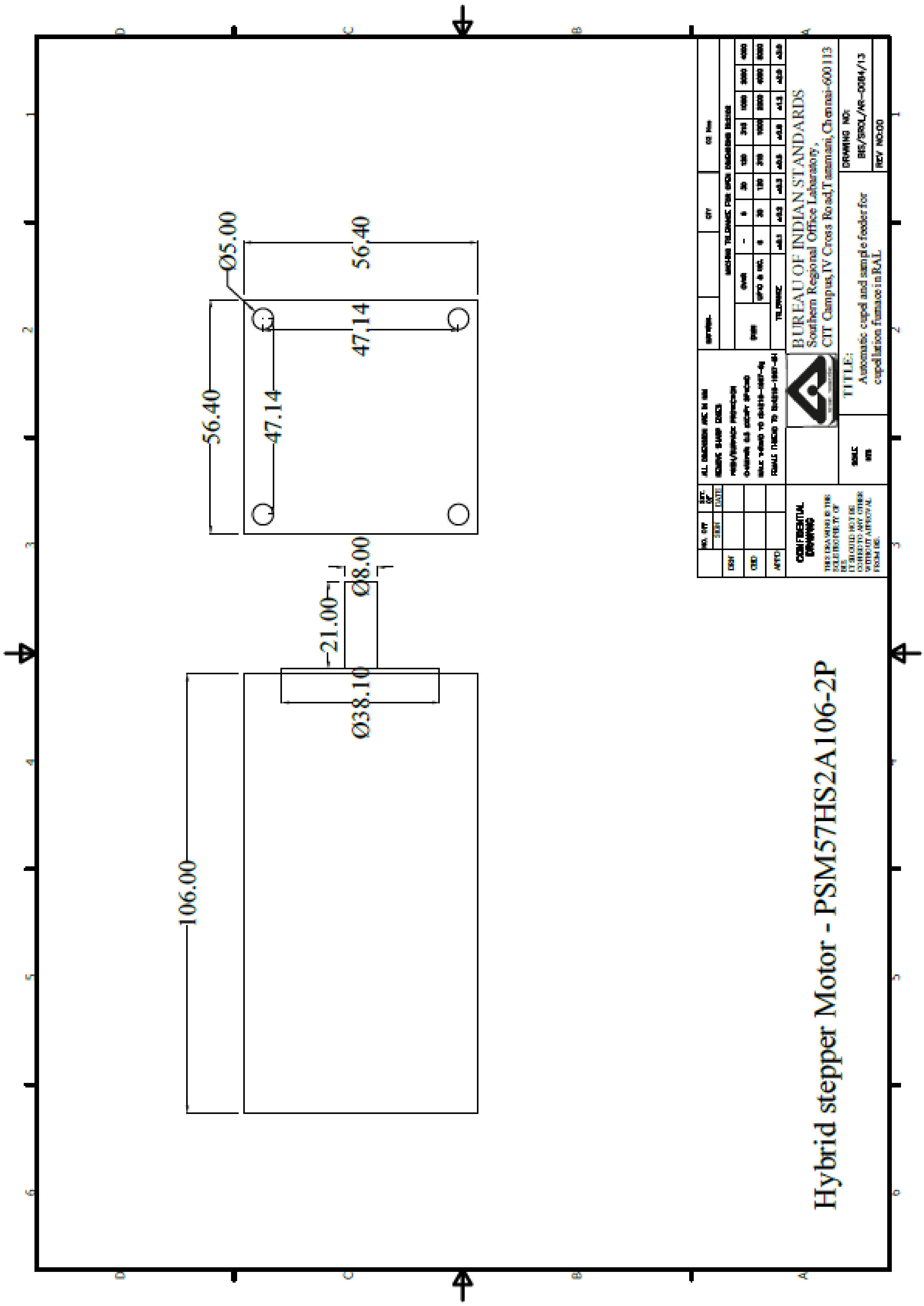
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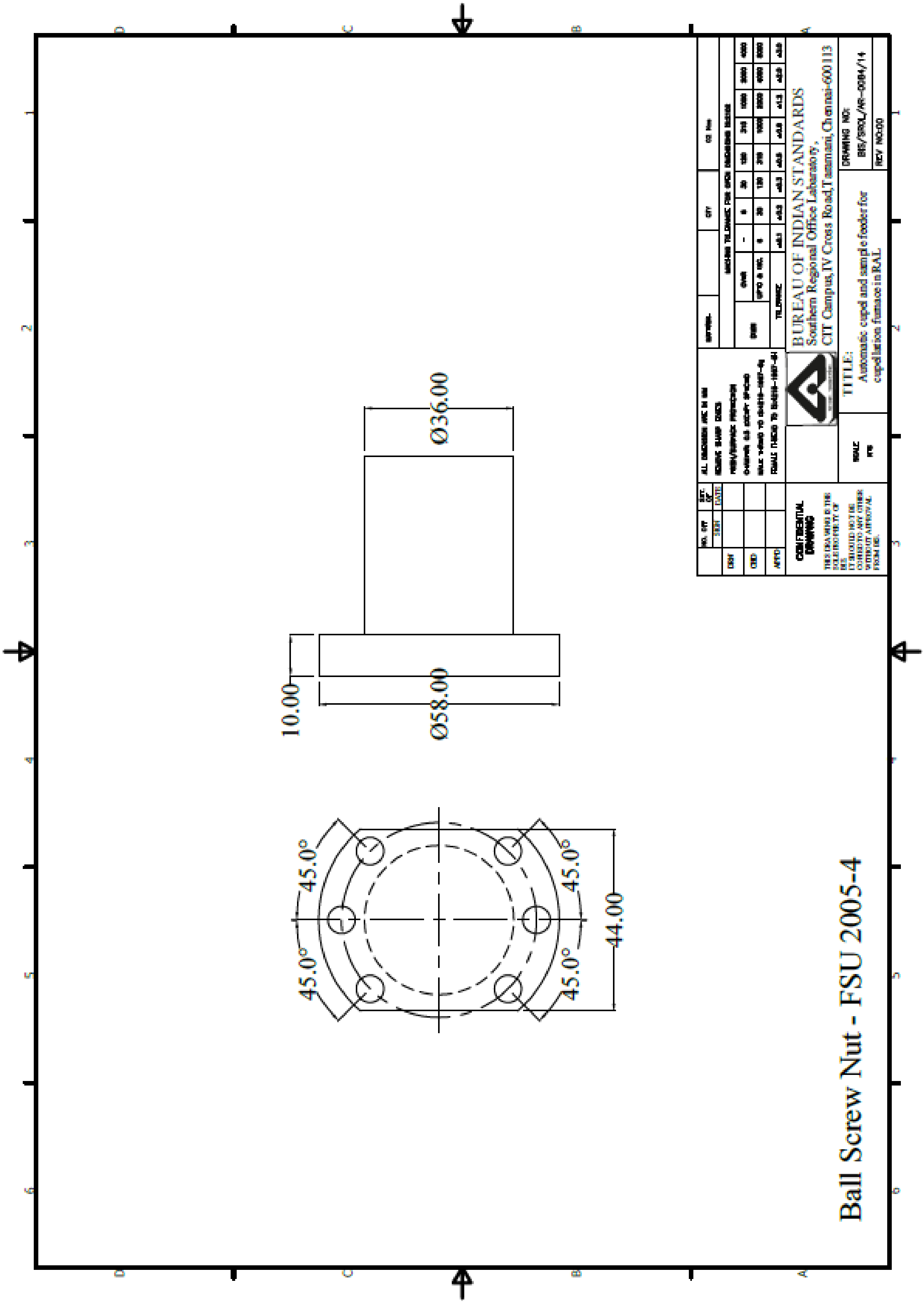
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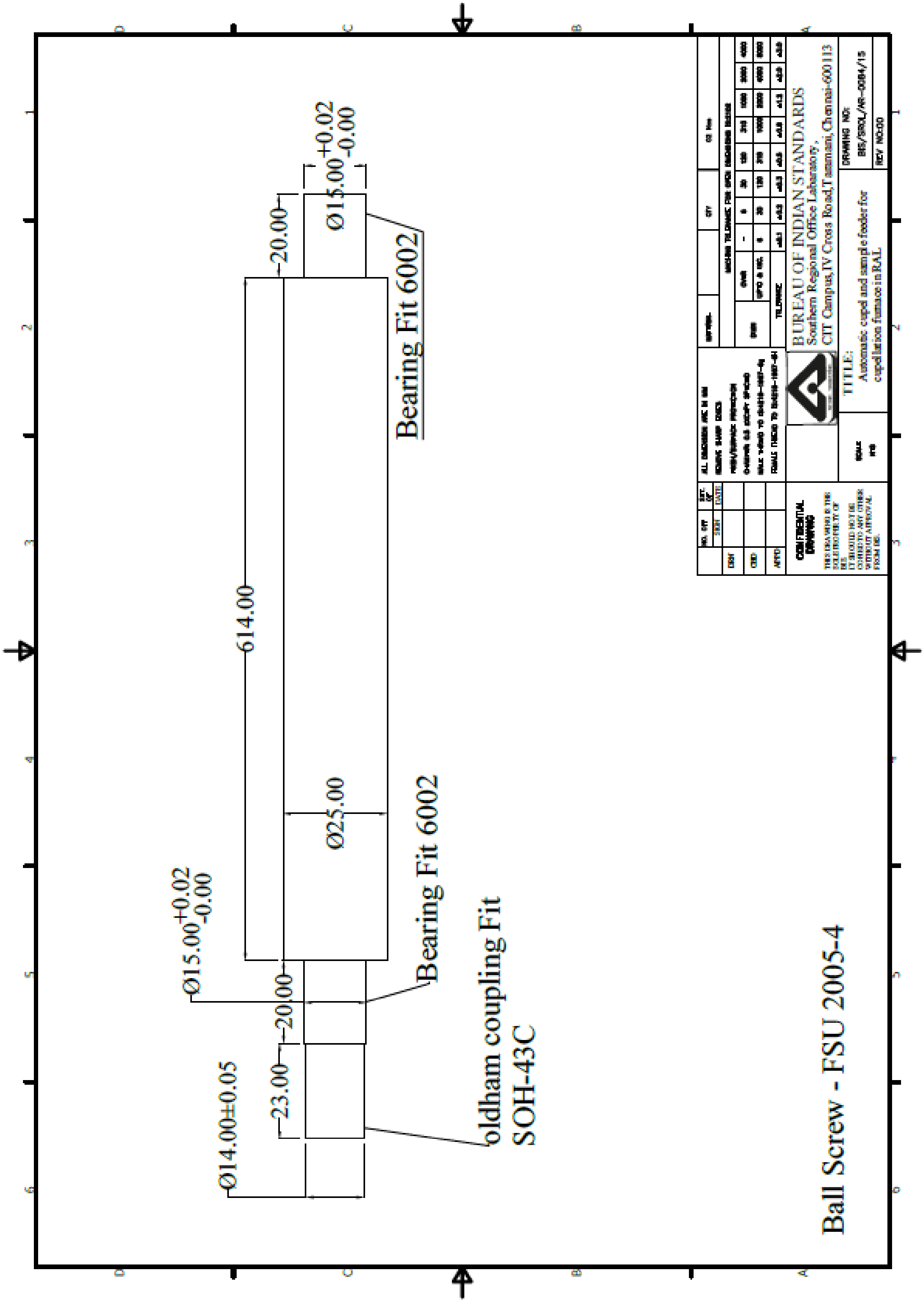
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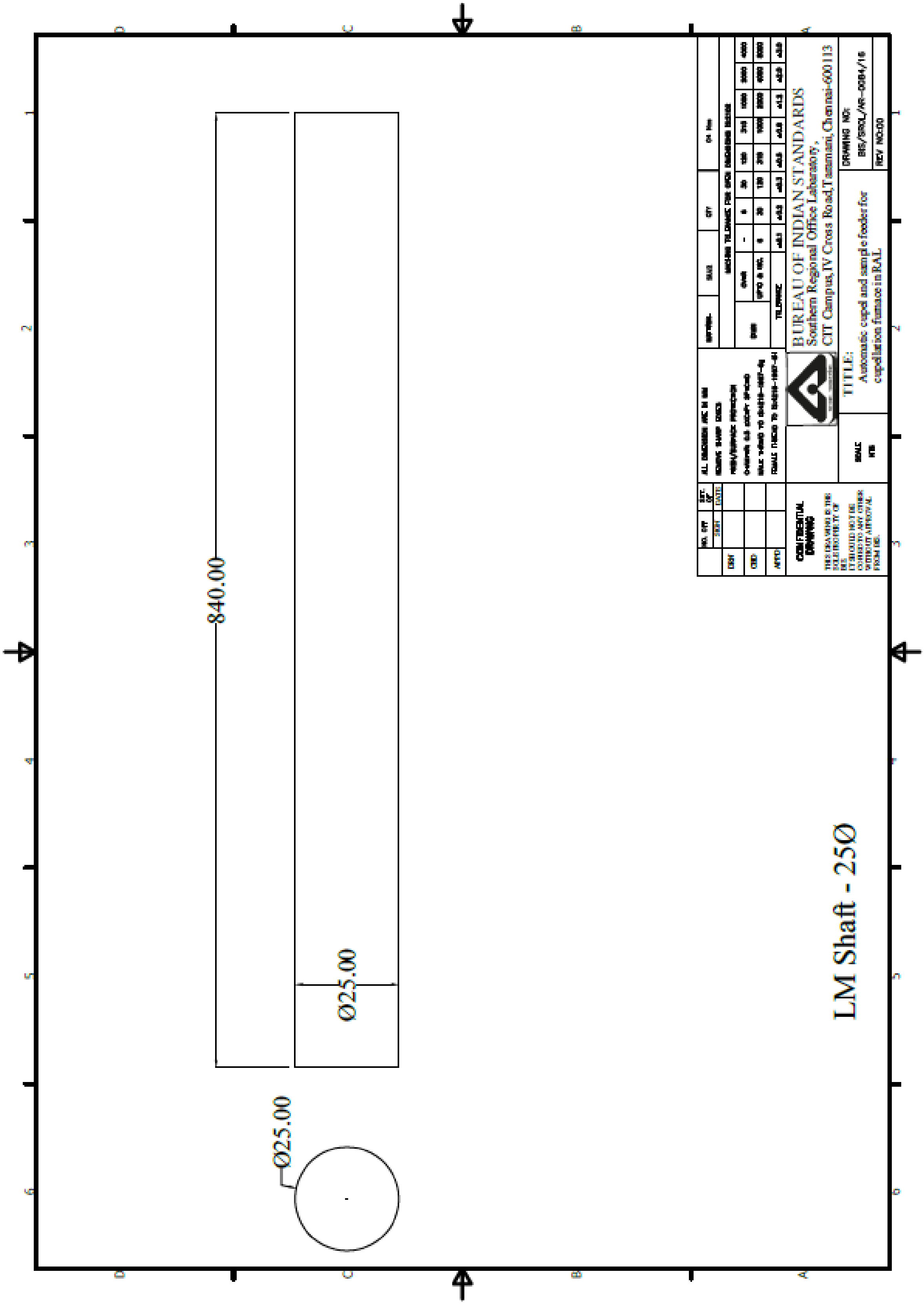
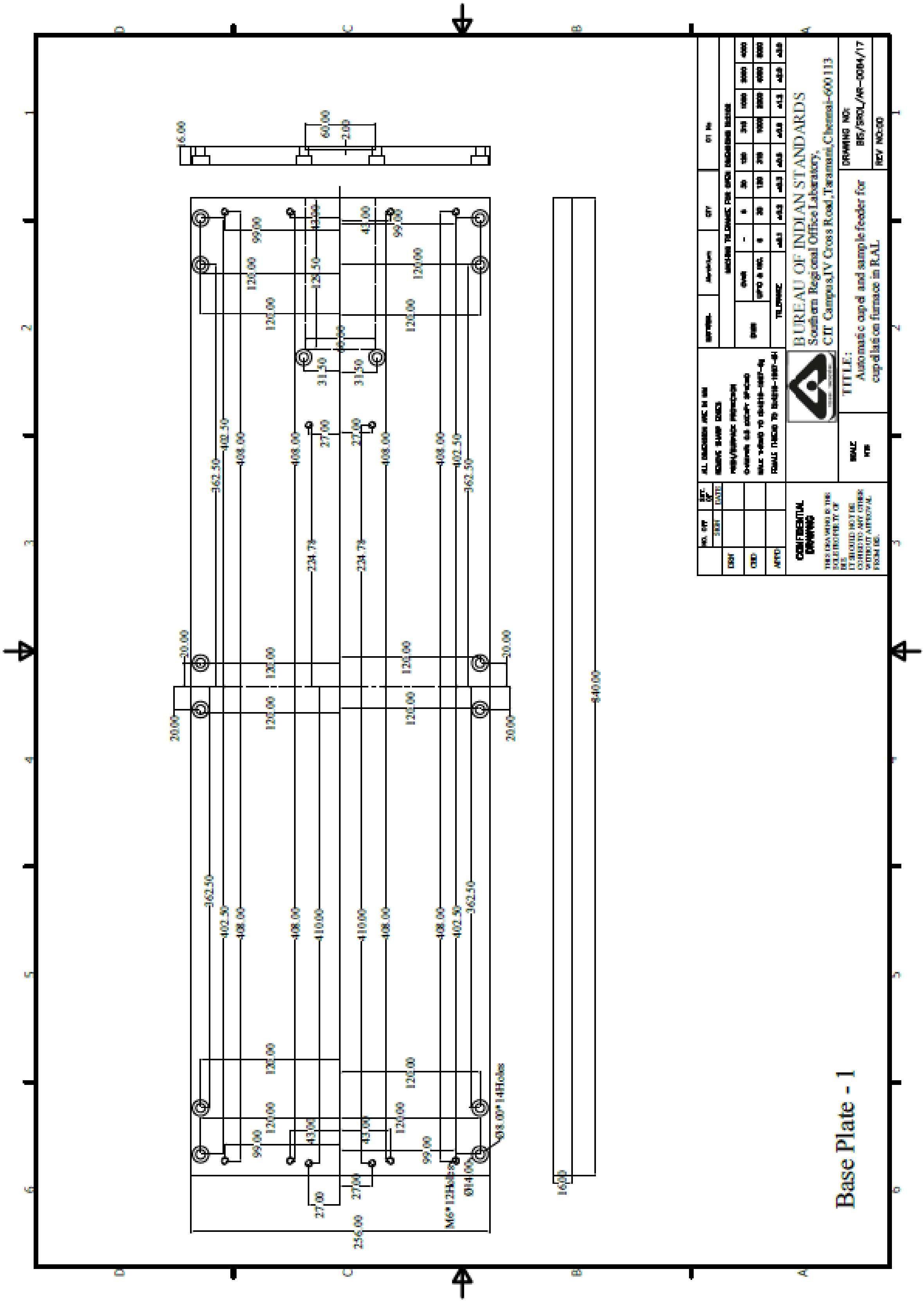
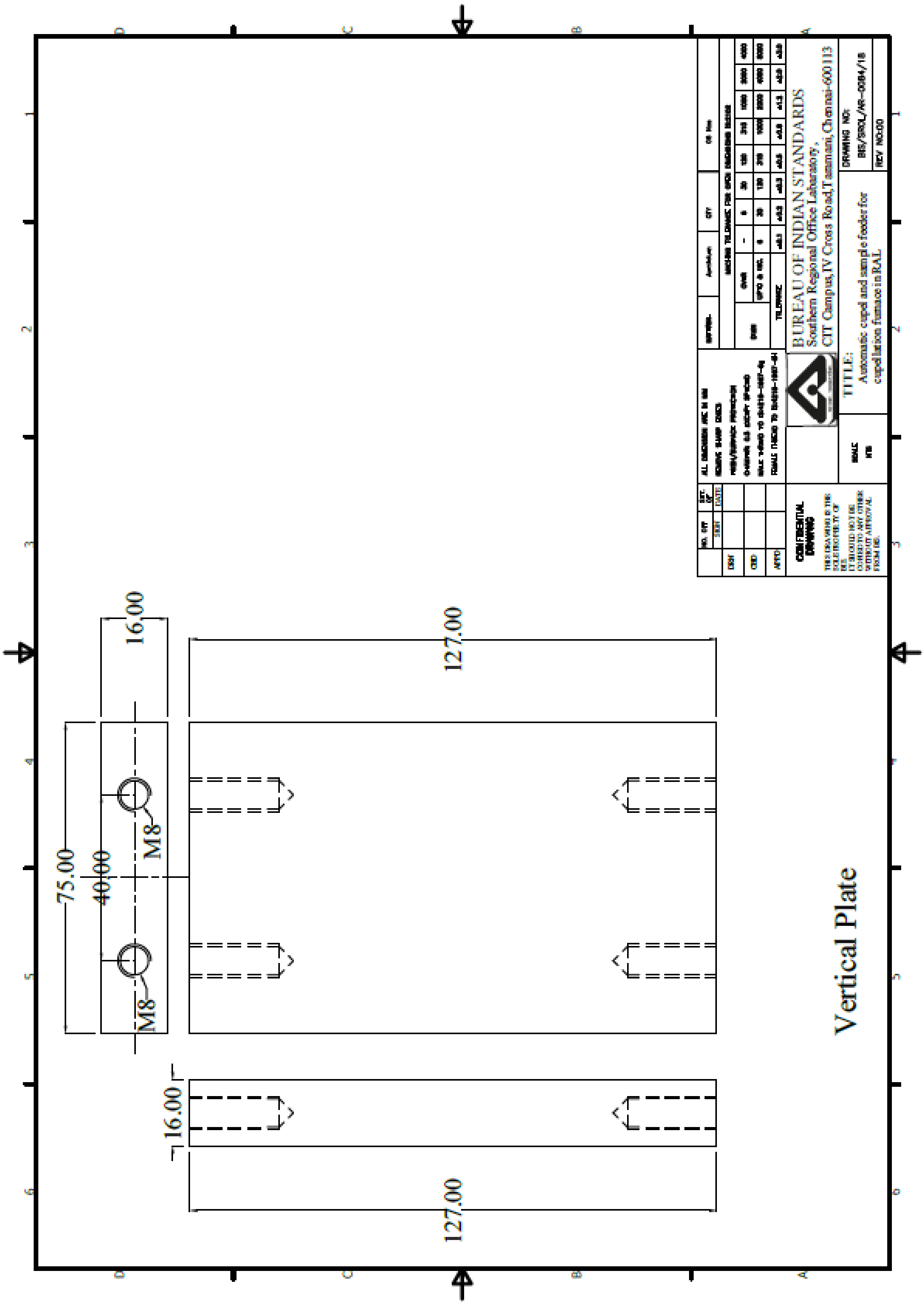
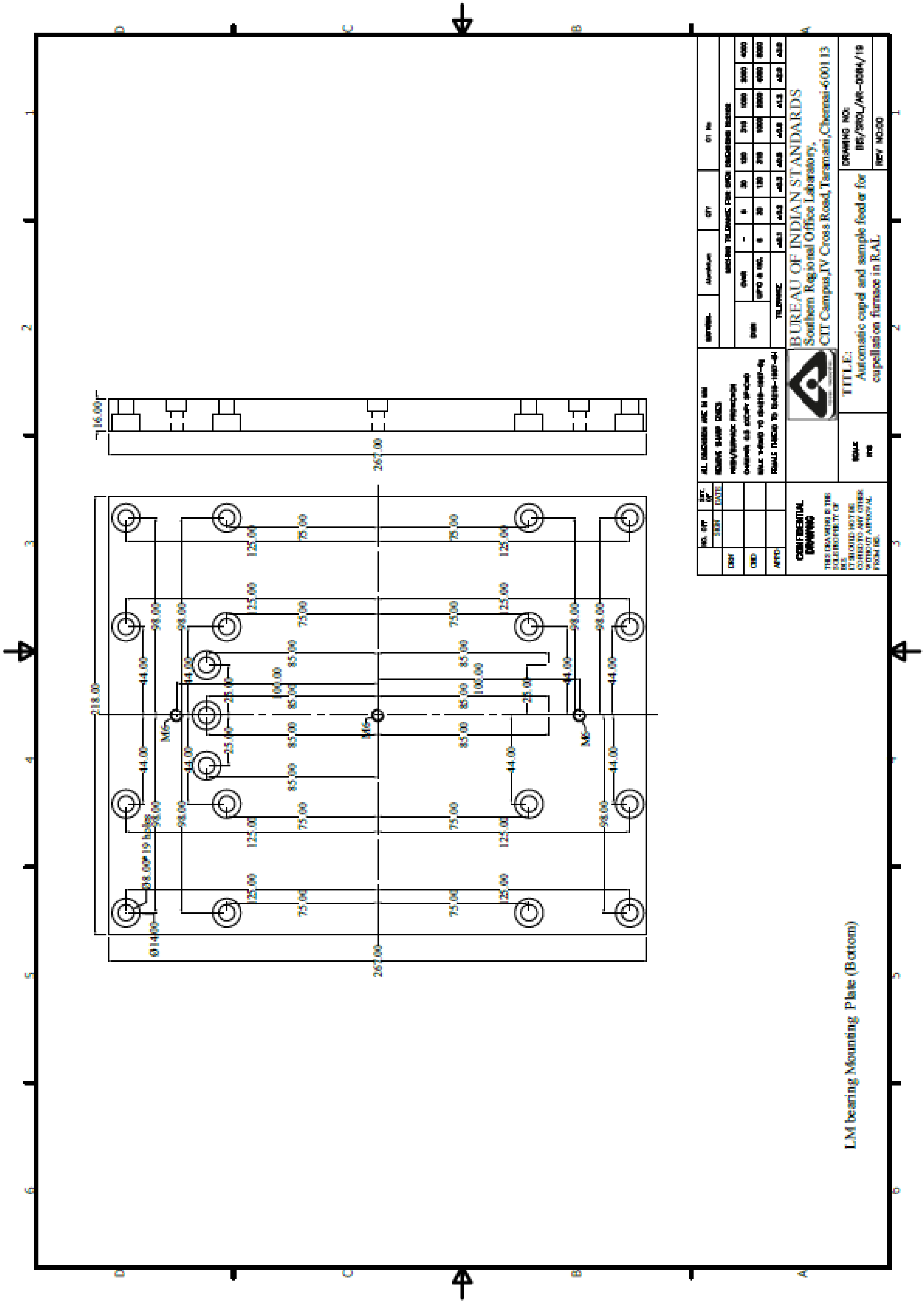
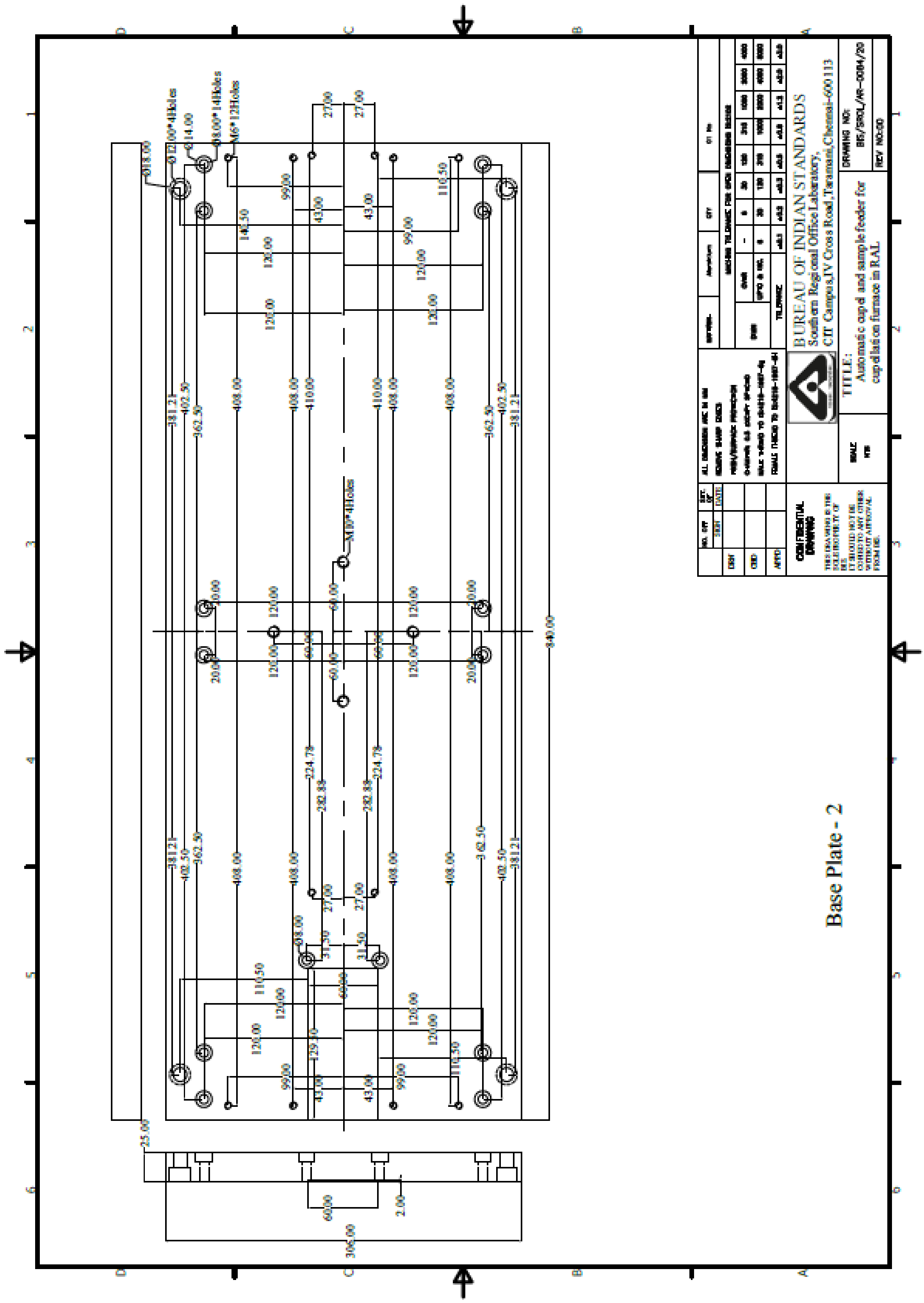
Ball Screw - FSU 2005-4
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600 113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
CONFIDENTIAL DRAWING

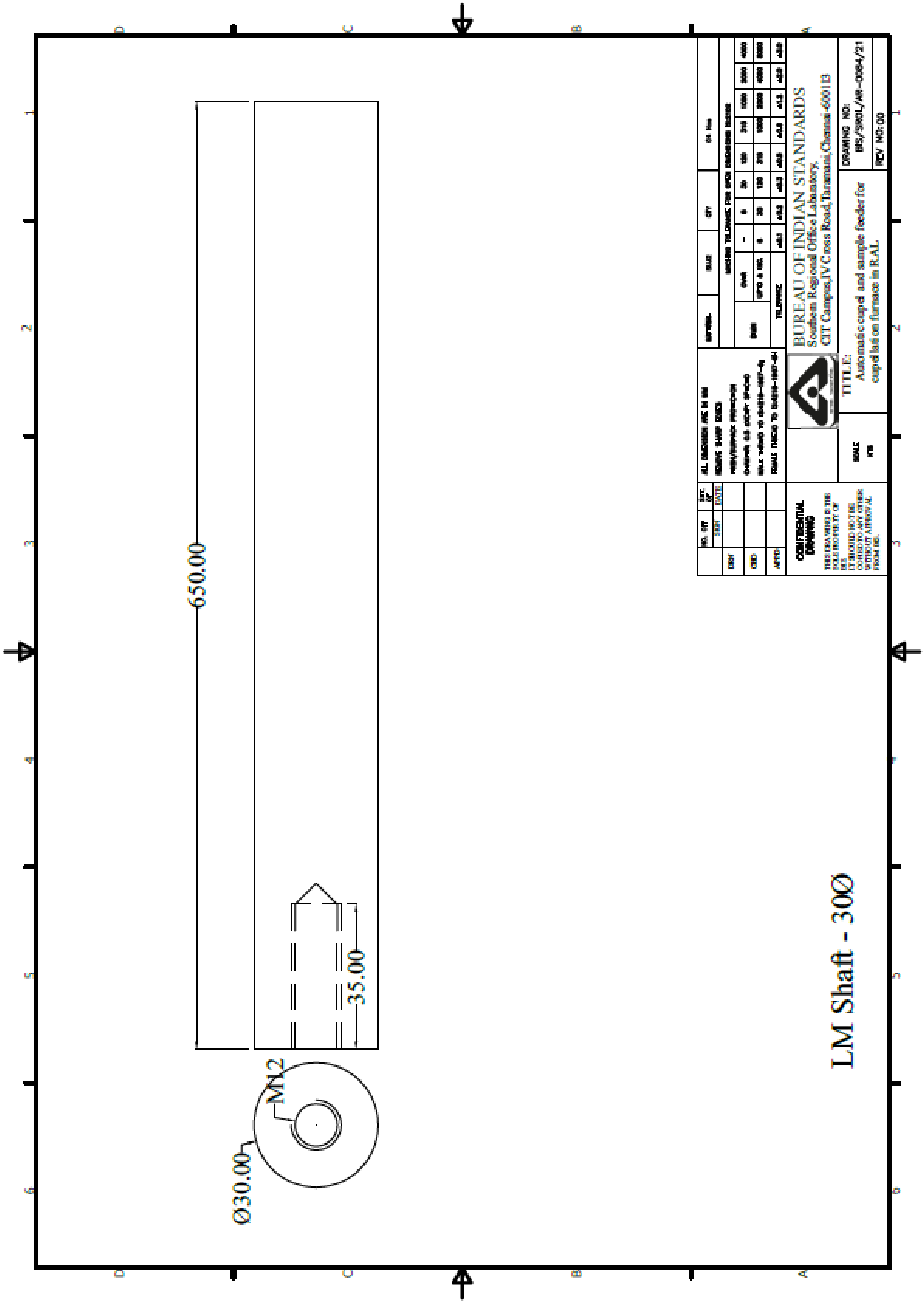

840.00
Ø25.00
Ø25.00
LM Shaft - 25Ø
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600 113
TITLE:
Automatic cupel and sample feeder for
cupellation furnace in RAL
REV NO:00

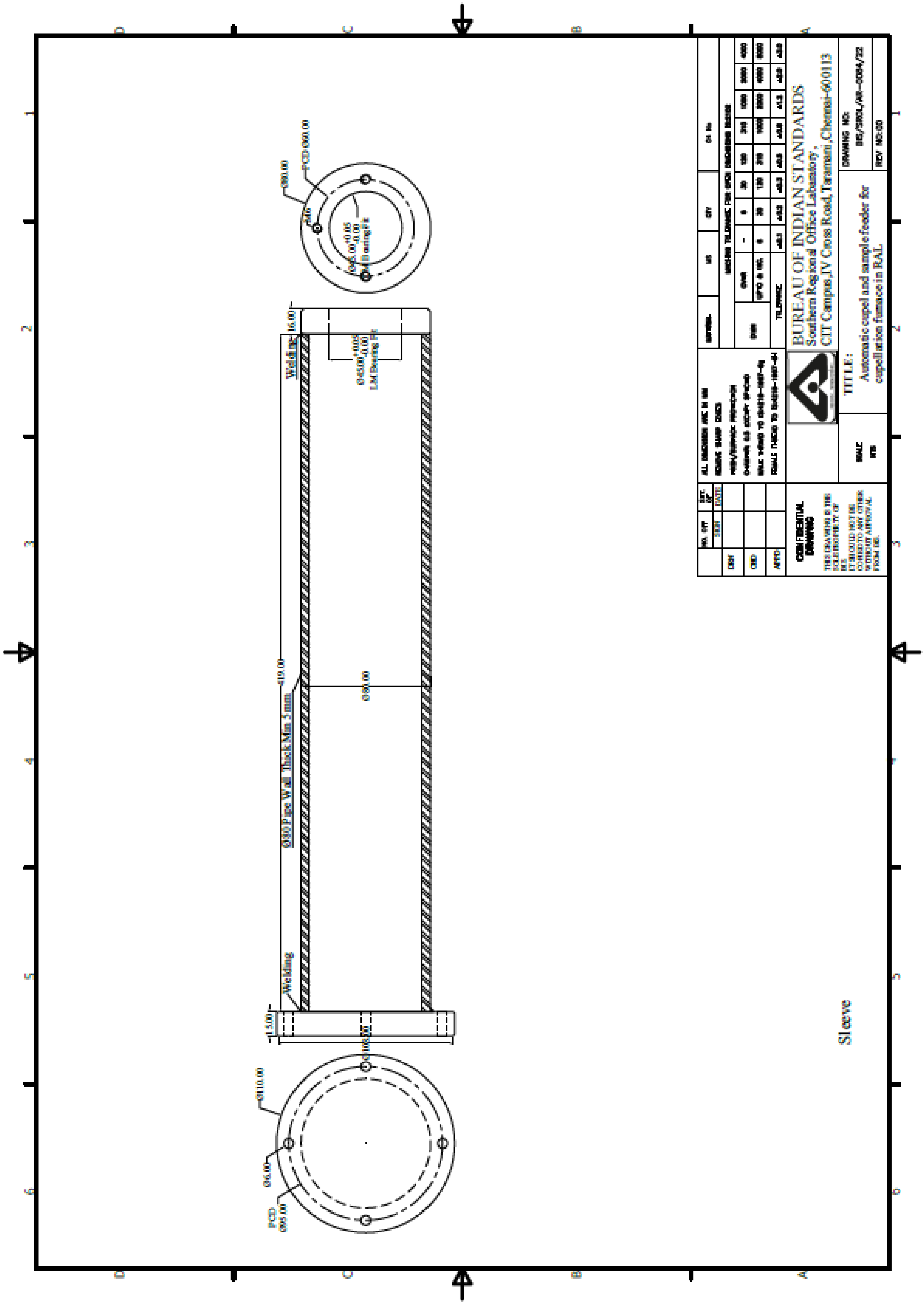

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600 113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
REV NO:00
Base Plate - 1

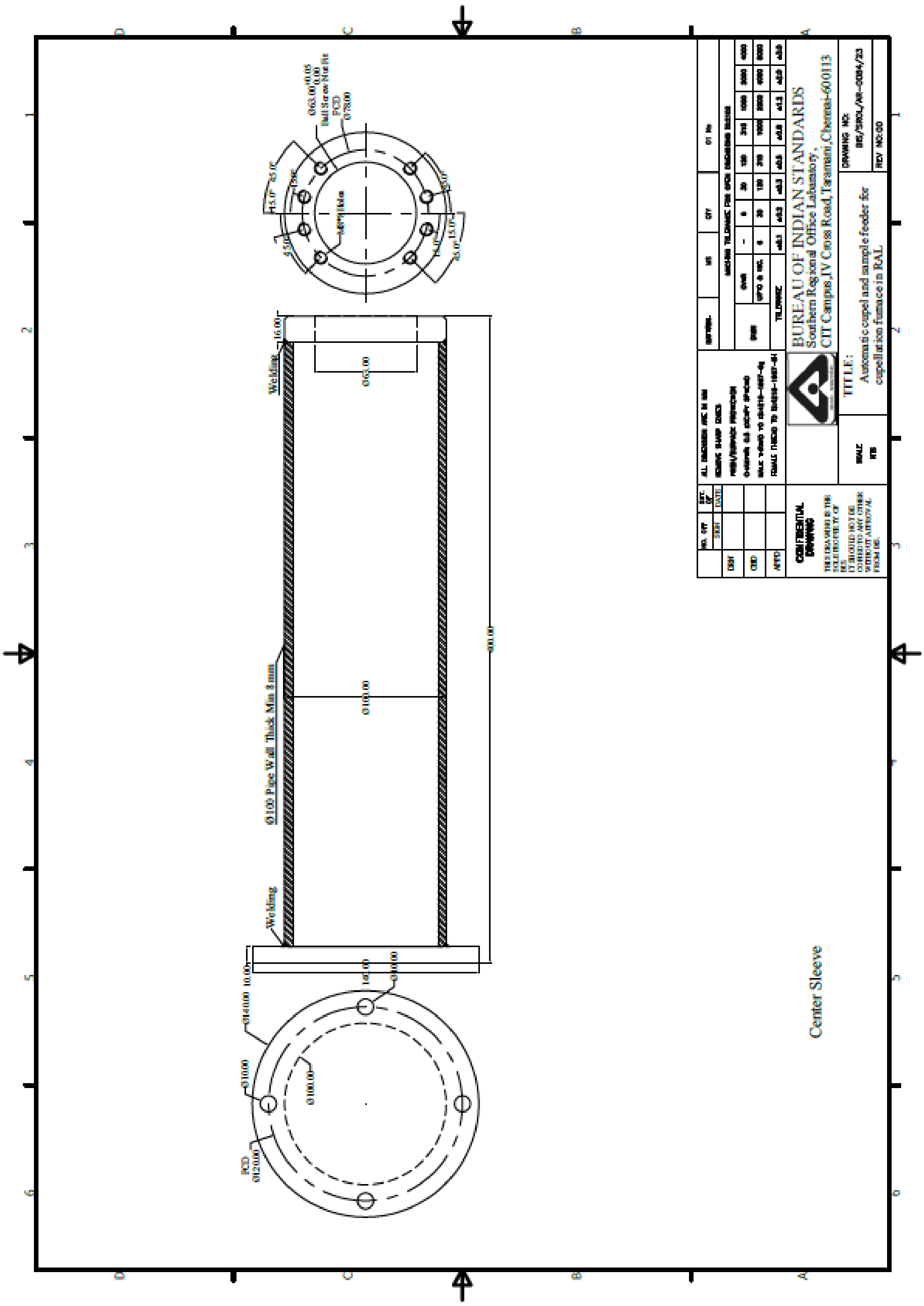

Vertical Plate
16.00
127.00
75.00
40.00
M8
M8
16.00
127.00
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
CONFIDENTIAL DRAWING
REV NO:00

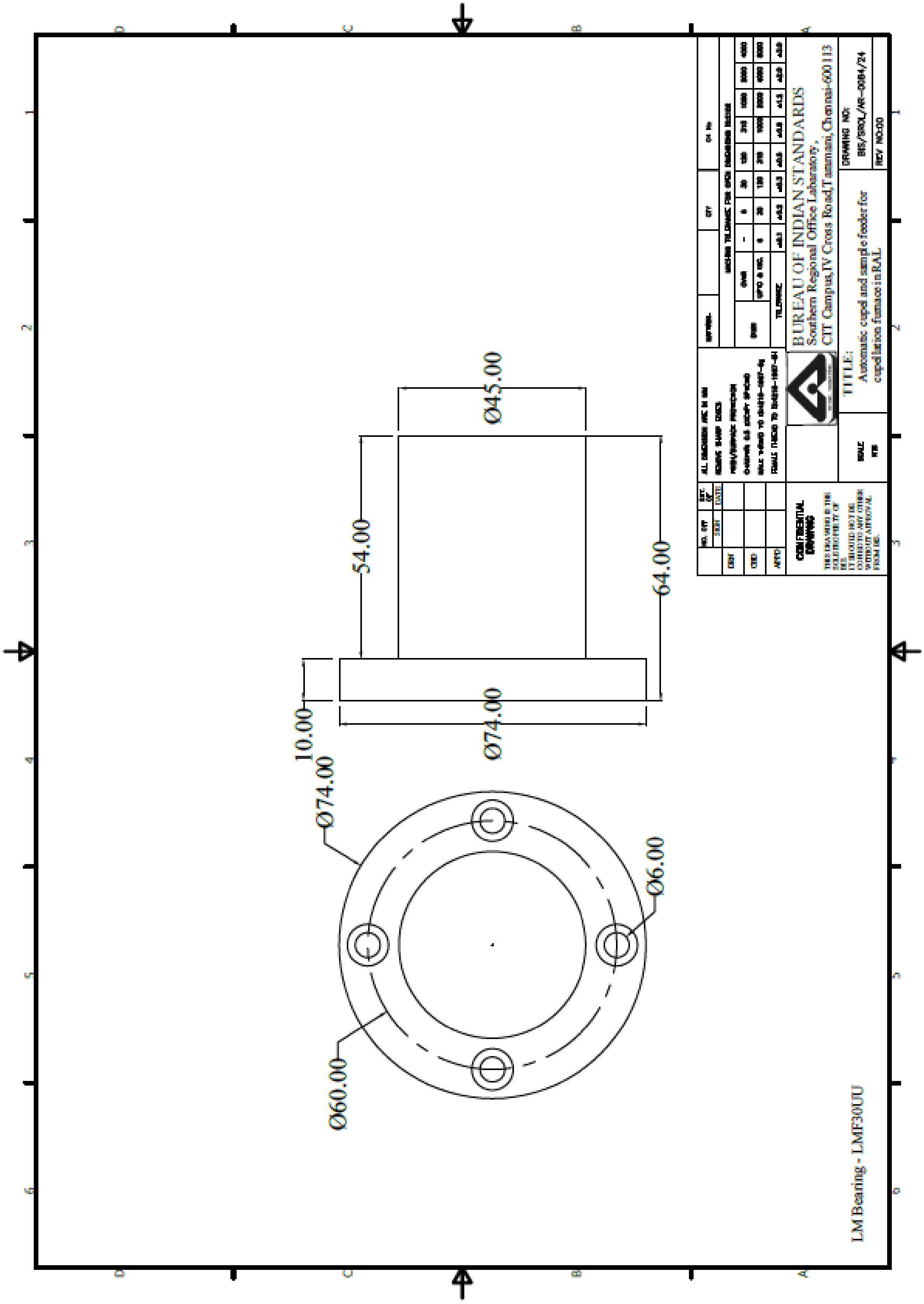

LM bearing Mounting Plate (Bottom)
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for
cupellation furnace in RAL
DRAWING NO:
REV NO:00
267.00
218.00
16.00

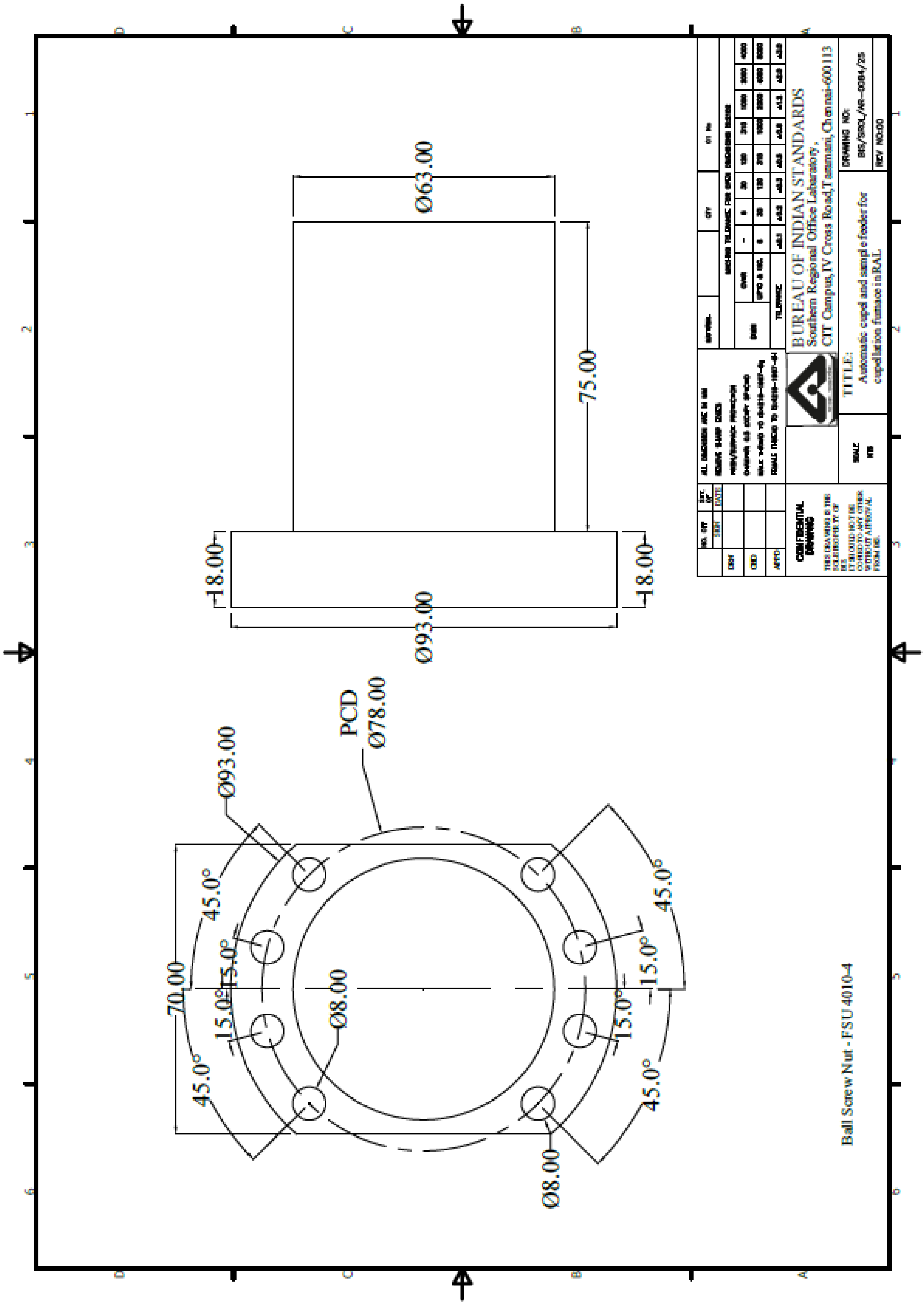

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600 113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
Base Plate - 2

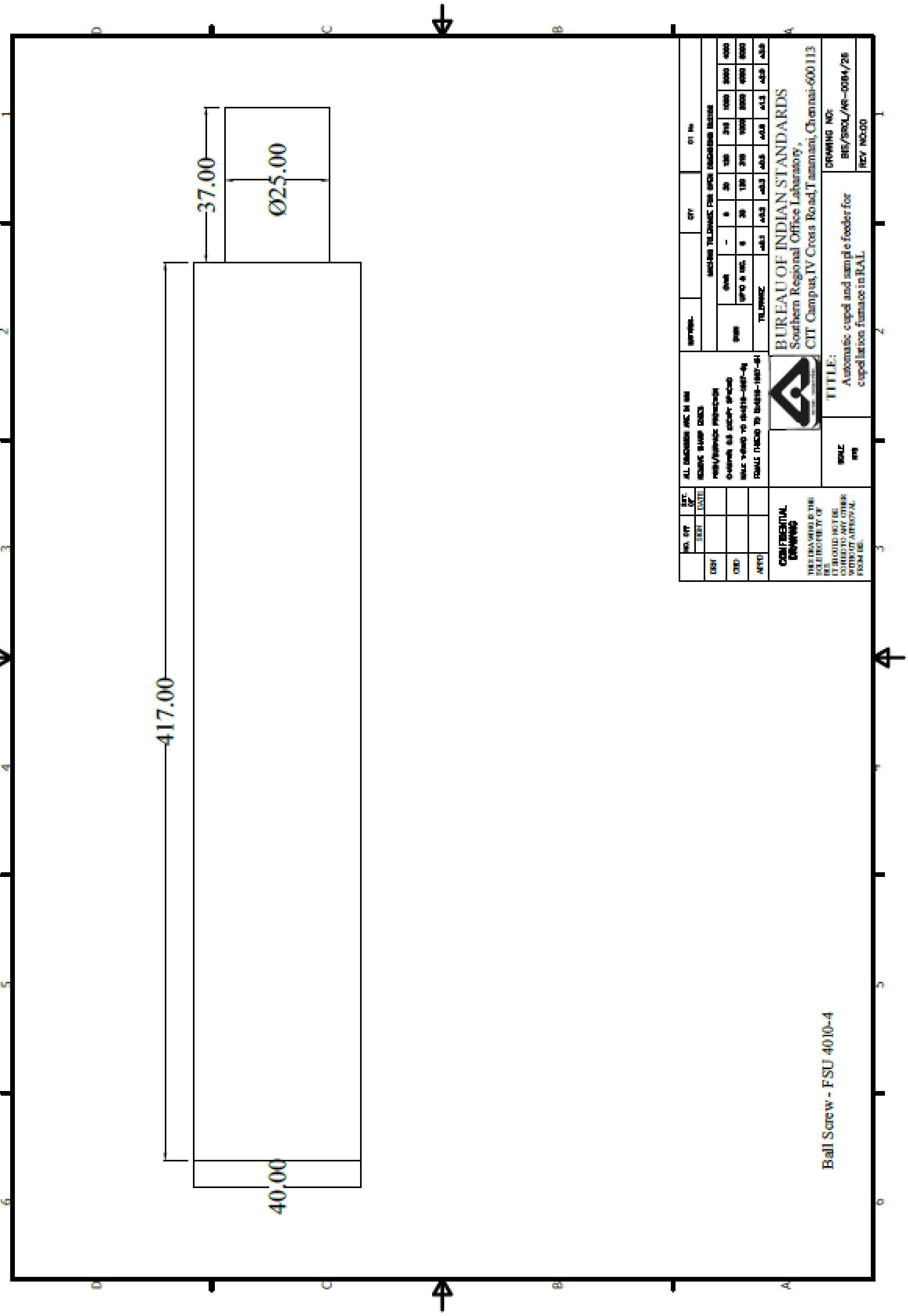

650.00
35.00
M12
Ø30.00
LM Shaft - 30Ø
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in R.A.L.
DRAWING NO:
BIS/SROL/AR-0084/21
REV NO:00

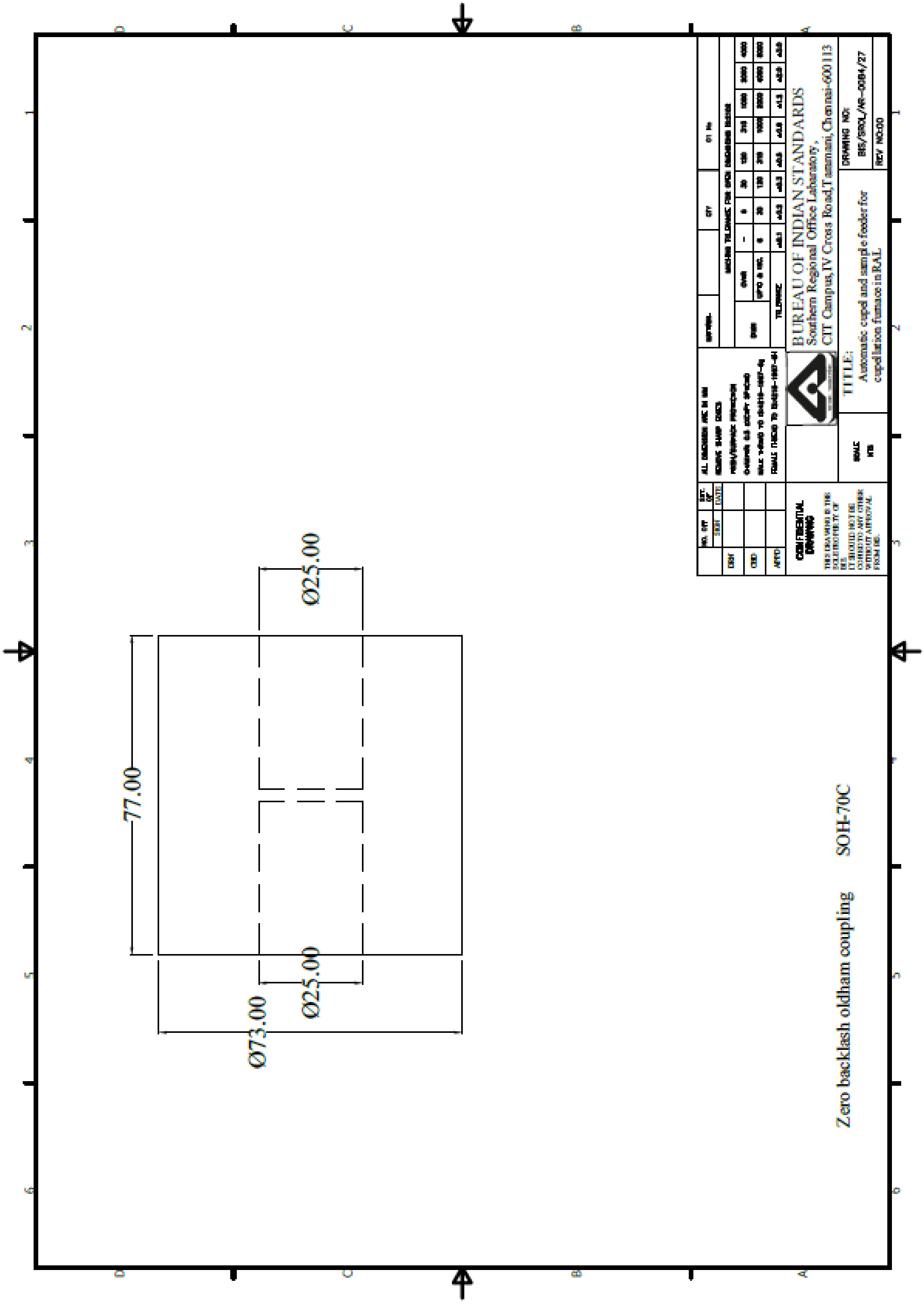

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
CONFIDENTIAL DRAWING
Ø90 Pipe Wall Thick Min 5 mm
Welding
Welding
Sleeve

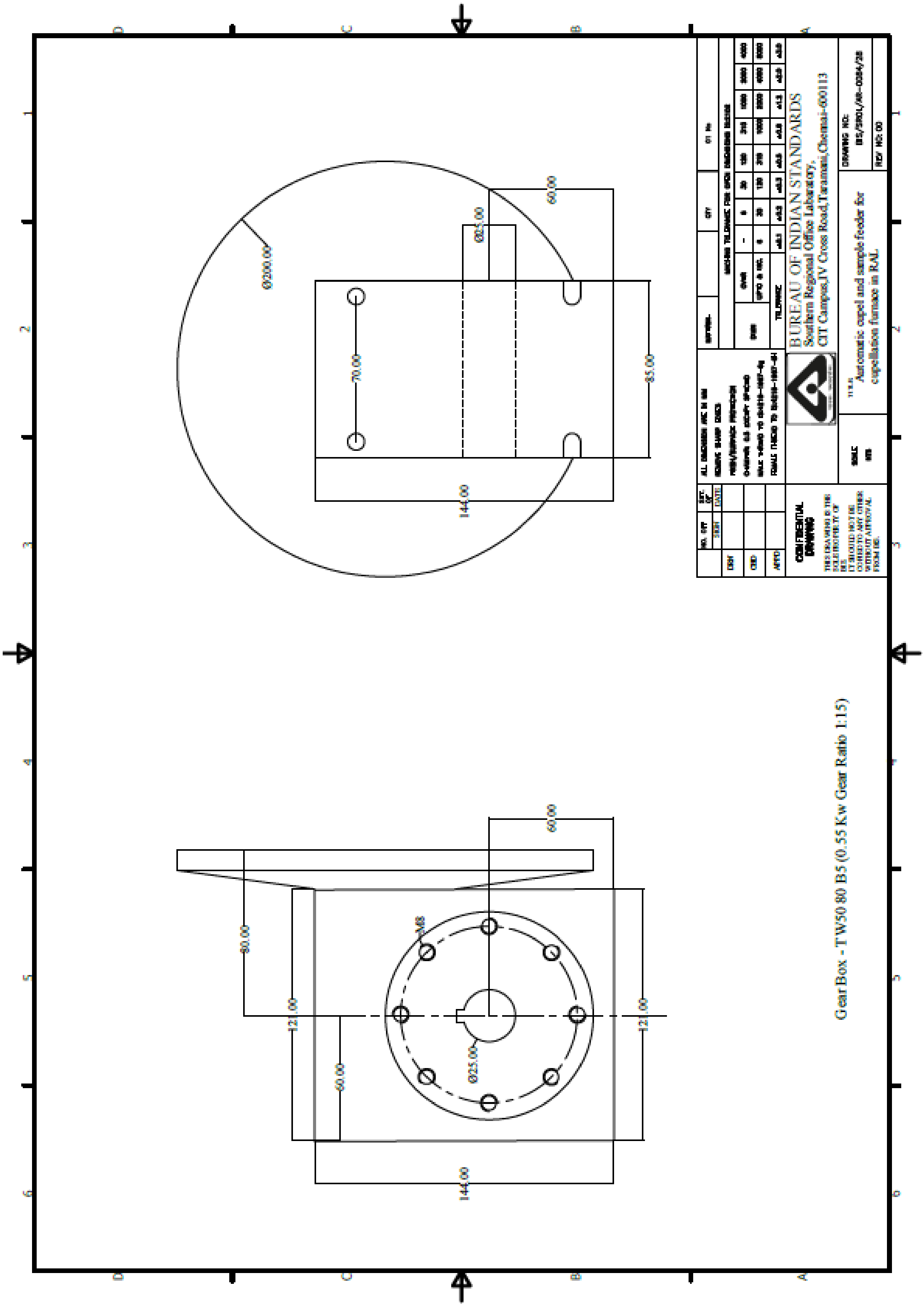

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
Ø100 Pipe Wall Thick Min 3mm
Welding
Welding
Center Sleeve

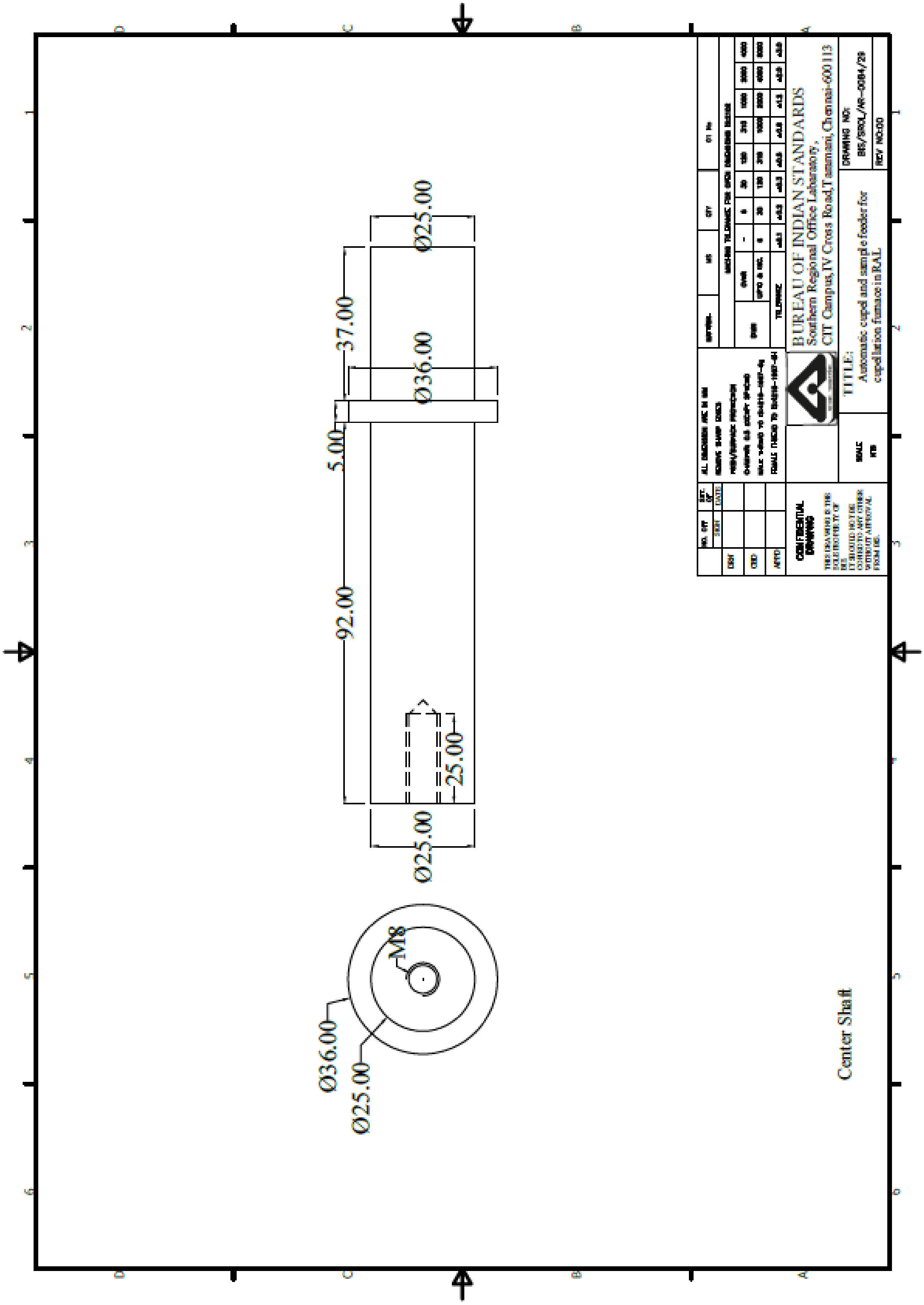

Ø45.00
54.00
64.00
10.00
Ø74.00
Ø74.00
Ø6.00
Ø60.00
LM Bearing - LMF30UU
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600 113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
REV NO:00

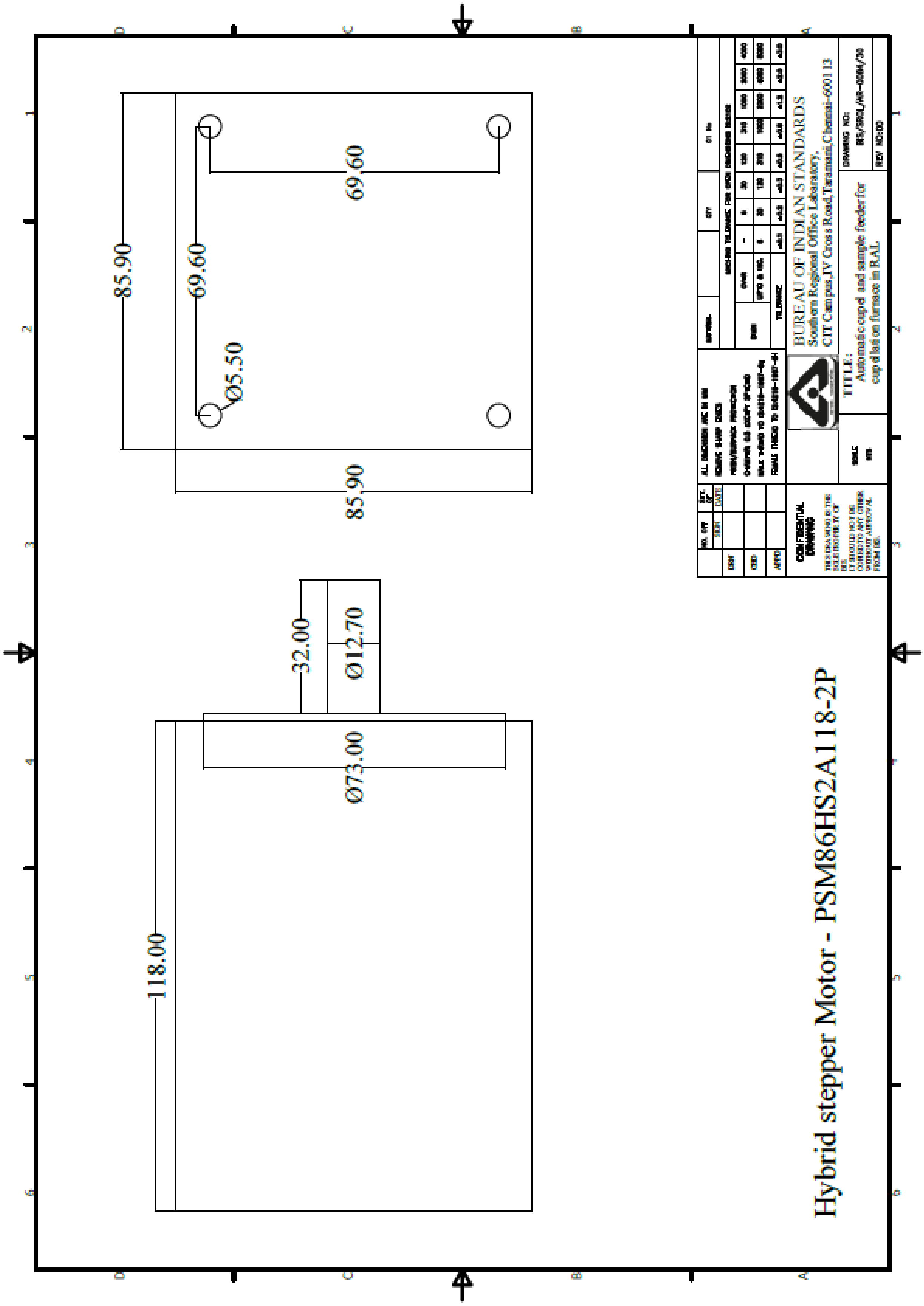

Ø63.00
75.00
18.00
18.00
Ø93.00
PCD
Ø78.00
Ø93.00
45.0°
45.0°
45.0°
45.0°
15.0°
15.0°
15.0°
15.0°
70.00
Ø8.00
Ø8.00
Ball Screw Nut - FSU 4010-4
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
REV NO:00
CONFIDENTIAL DRAWING

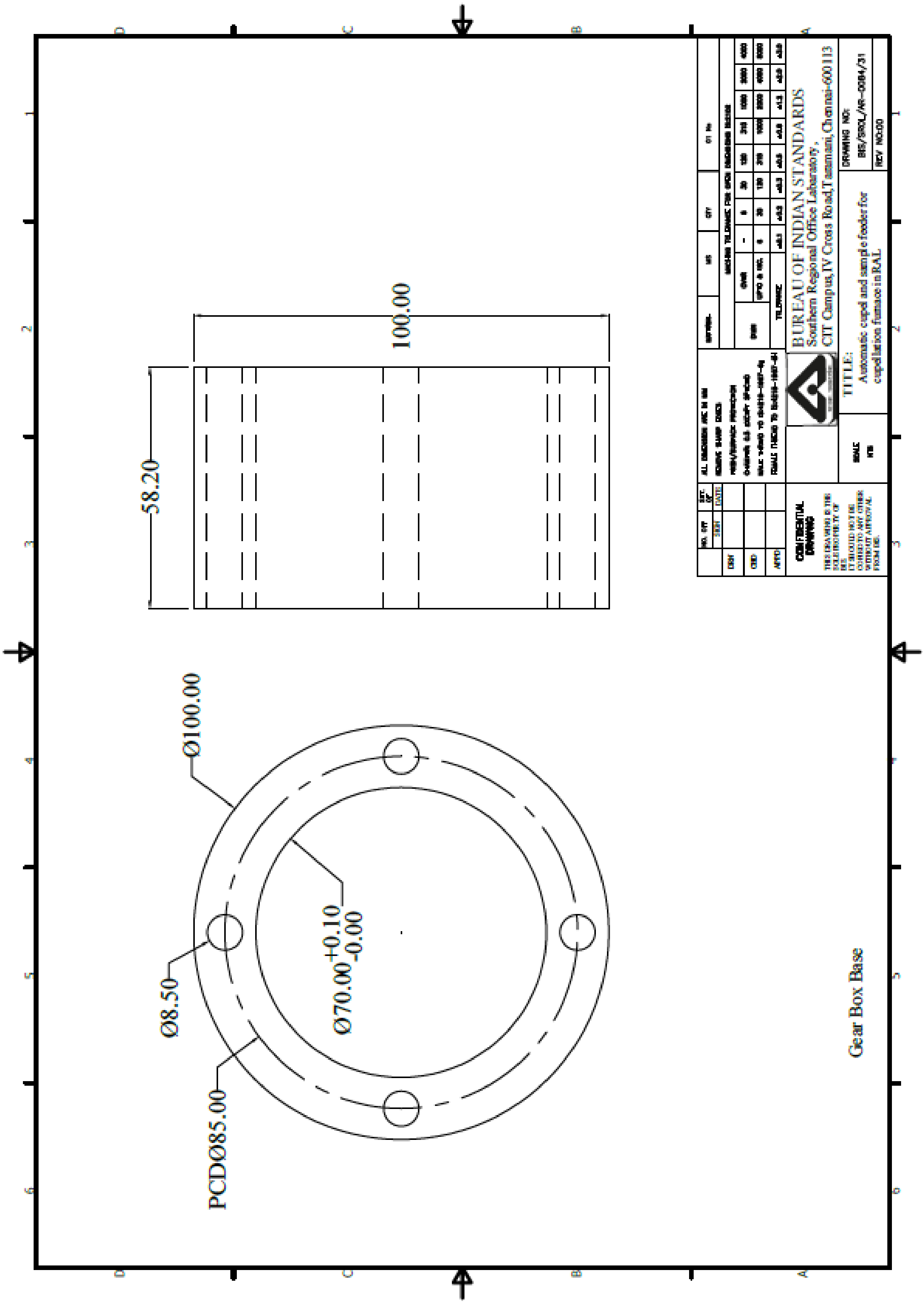

417.00
37.00
40.00
Ø25.00
Ball Screw - FSU 4010-4
CONFIDENTIAL DRAWING
BUREAU OF INDIAN STANDARDS
Southern Regional Office Labaratory,
CIT Campus,IV Cross Road,Tammani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
BIS/SROL/AR-0084/26
REV NO:00


Ø25.00
77.00
Ø25.00
Ø73.00
Zero backlash oldham coupling
SOH-70C
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani, Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
BIS/SROL/AR-0084/27
REV NO:00
CONFIDENTIAL DRAWING

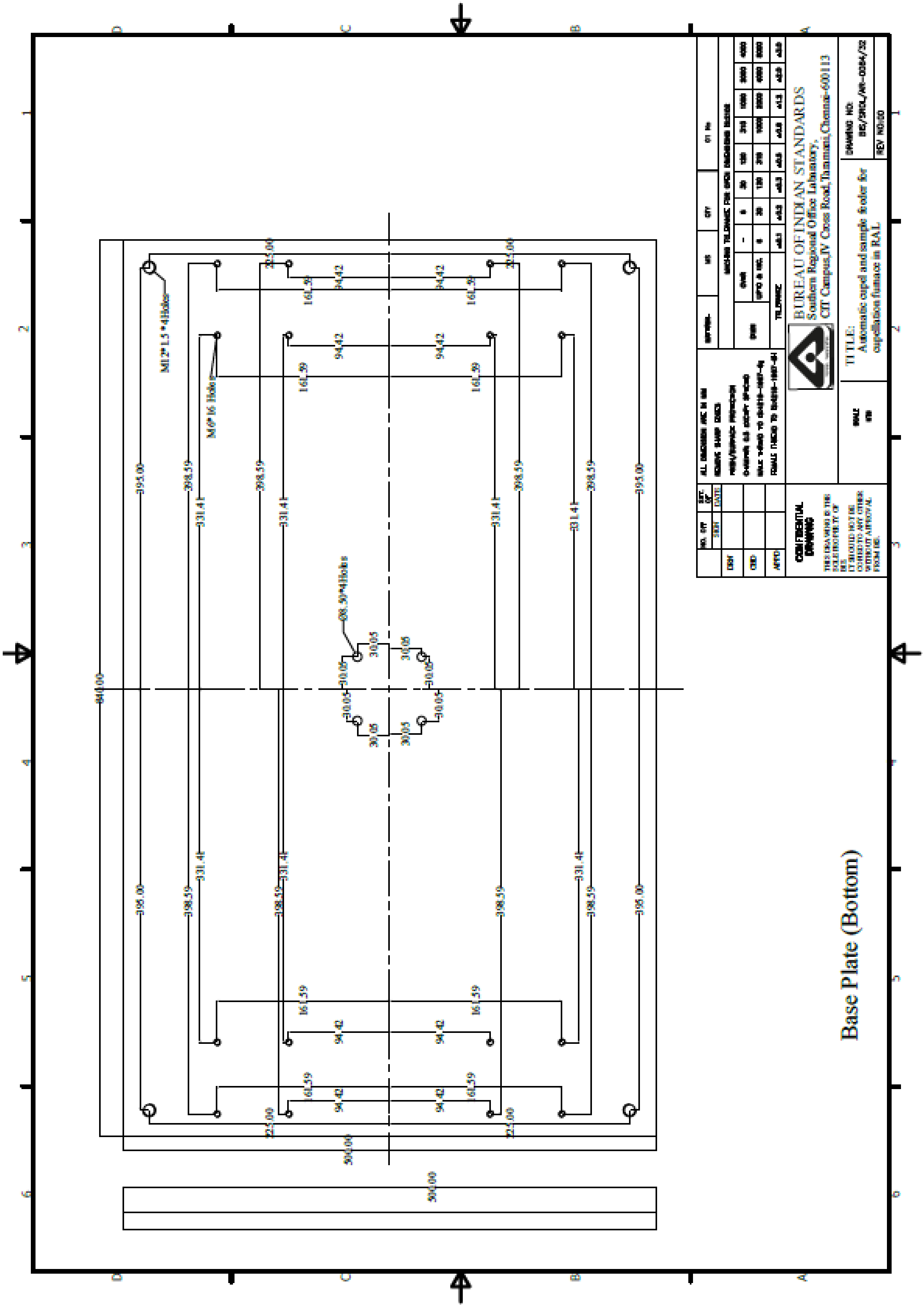

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
REV NO: 00
CONFIDENTIAL DRAWING
Gear Box - TW50 80 B5 (0.55 Kw Gear Ratio 1:15)
Ø200.00
Ø25.00
60.00
70.00
85.00
144.00
80.00
121.00
M8

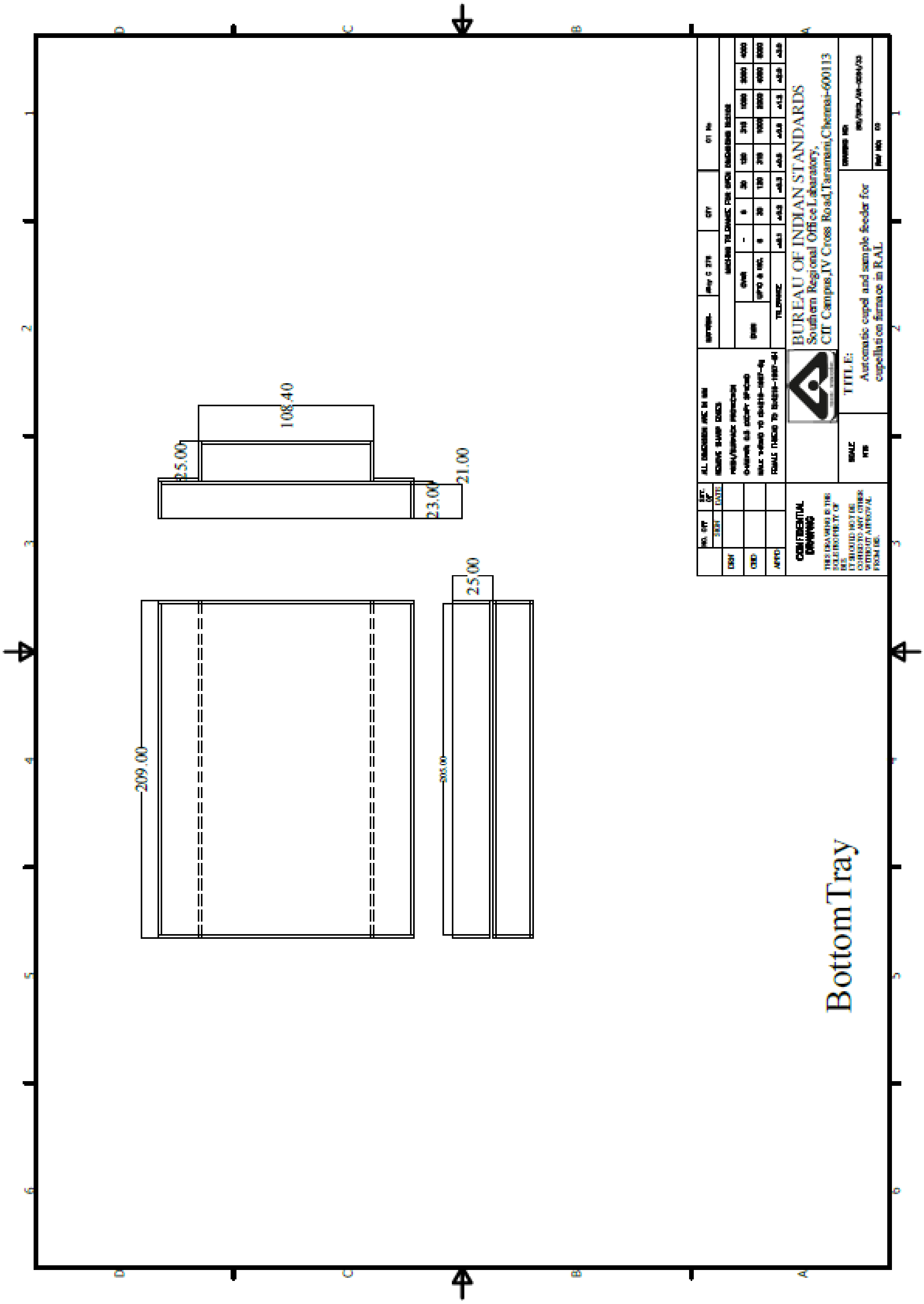

Ø25.00
37.00
Ø36.00
5.00
92.00
25.00
Ø25.00
M8
Ø36.00
Ø25.00
Center Shaft
CONFIDENTIAL DRAWING
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
REV NO:00

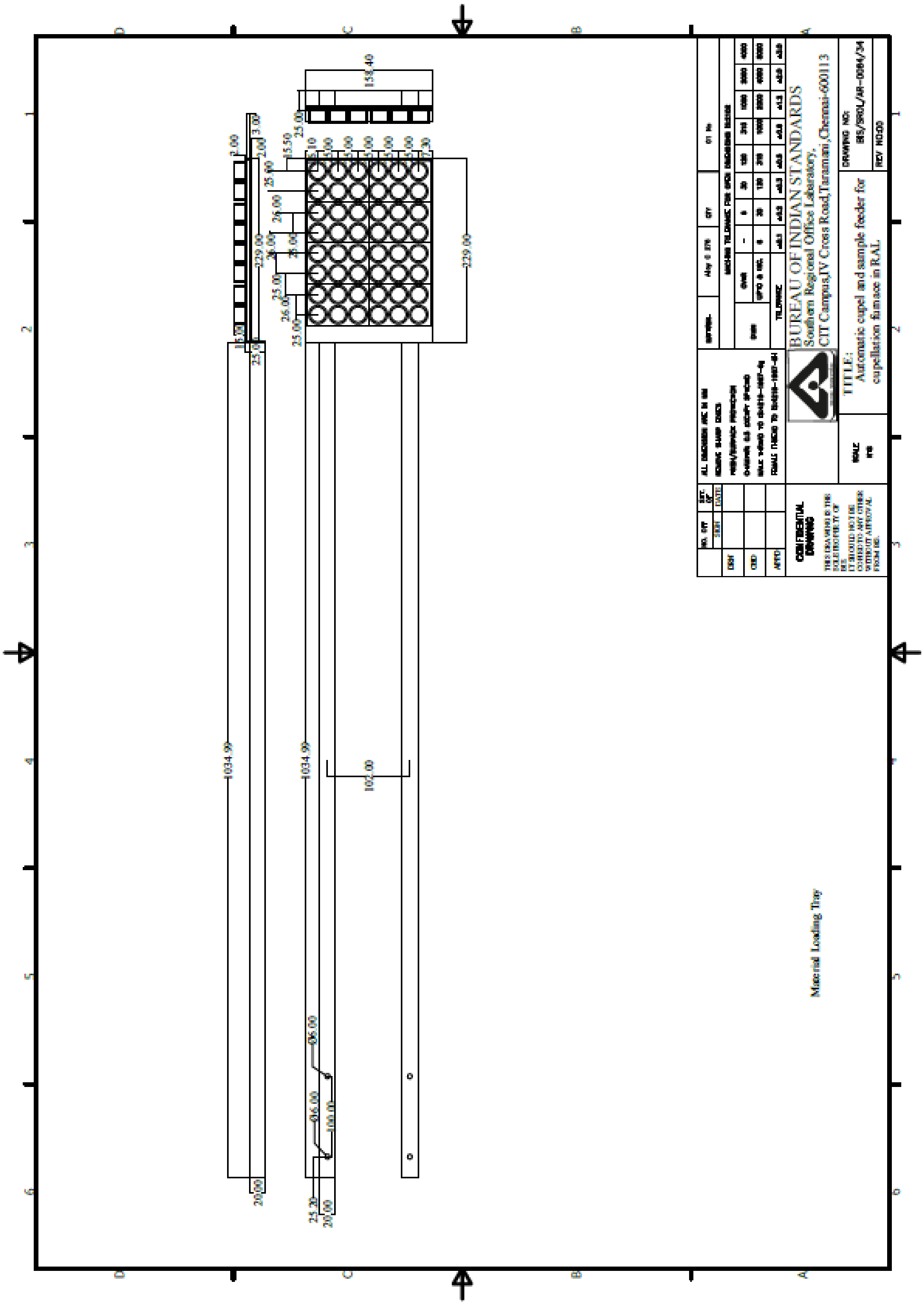

85.90
69.60
Ø5.50
69.60
85.90
32.00
Ø12.70
Ø73.00
118.00
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus, IV Cross Road, Taramani, Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
CONFIDENTIAL DRAWING
Hybrid stepper Motor - PSM86HS2A118-2P

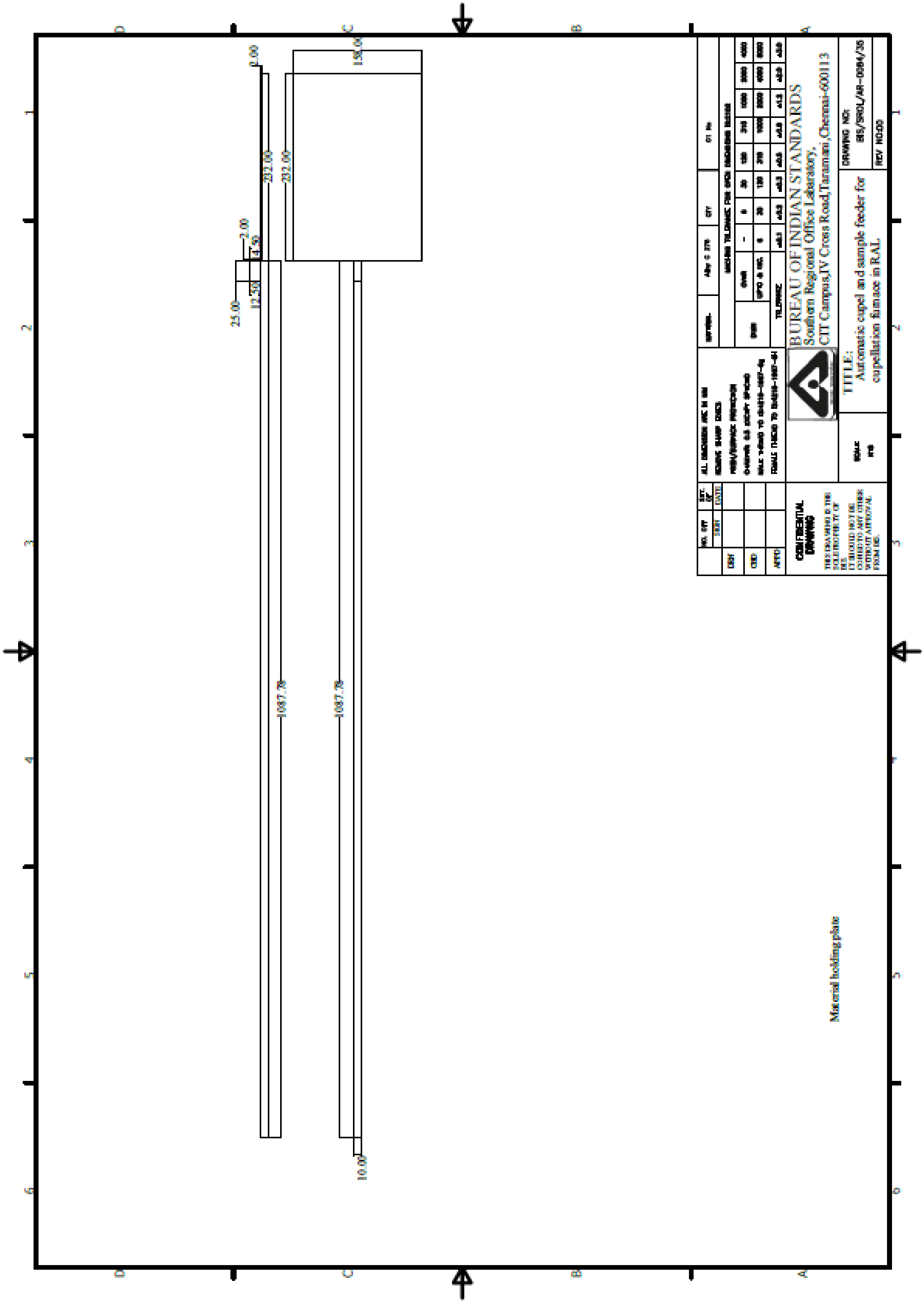


58.20
100.00
Ø100.00
Ø8.50
Ø70.00 +0.10 -0.00
PCDØ85.00
Gear Box Base
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
REV NO:00

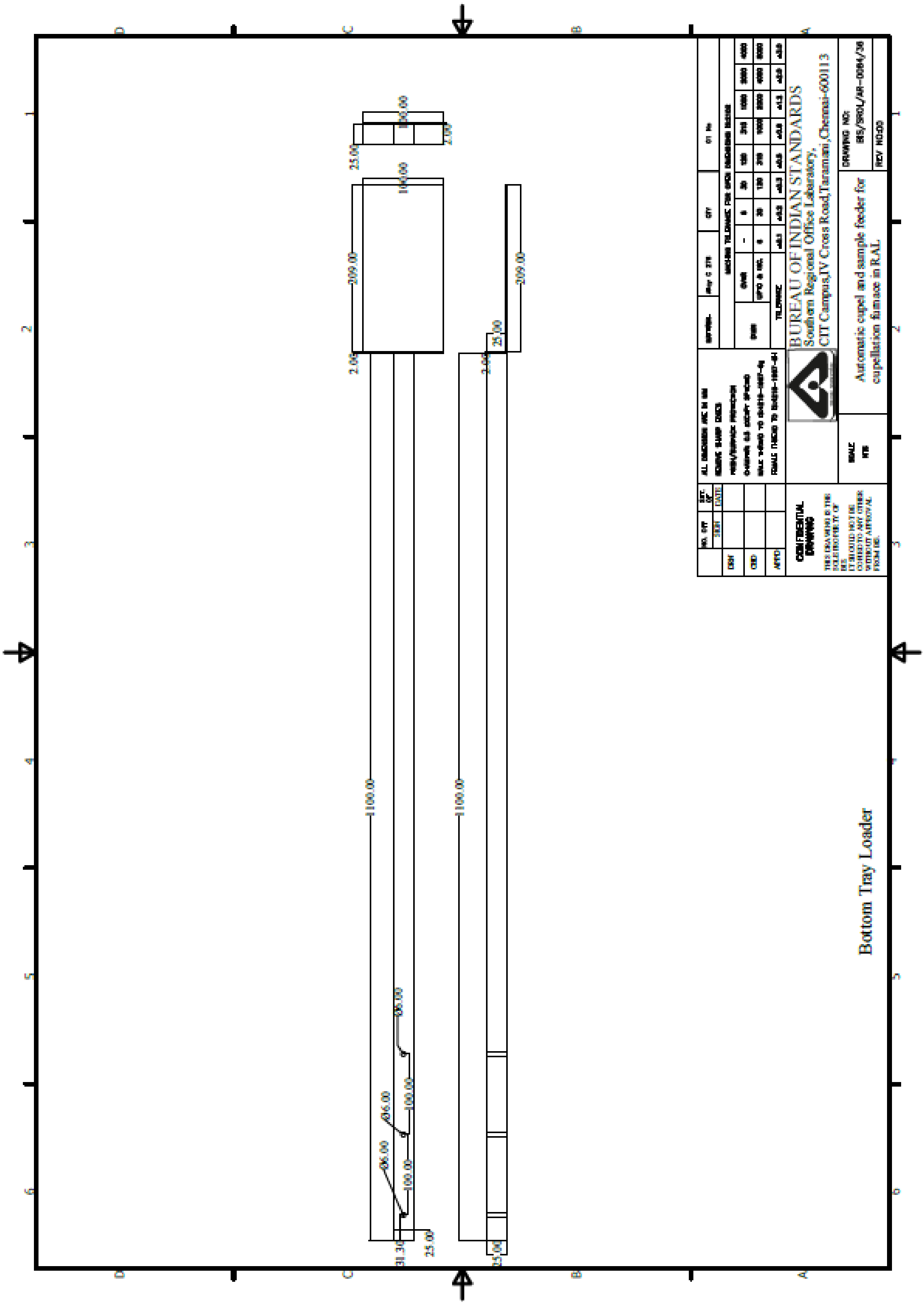

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
CONFIDENTIAL DRAWING
Base Plate (Bottom)


108.40
5.00
21.00
23.00
25.00
209.00
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for
cupellation furnace in RAL
BottomTray

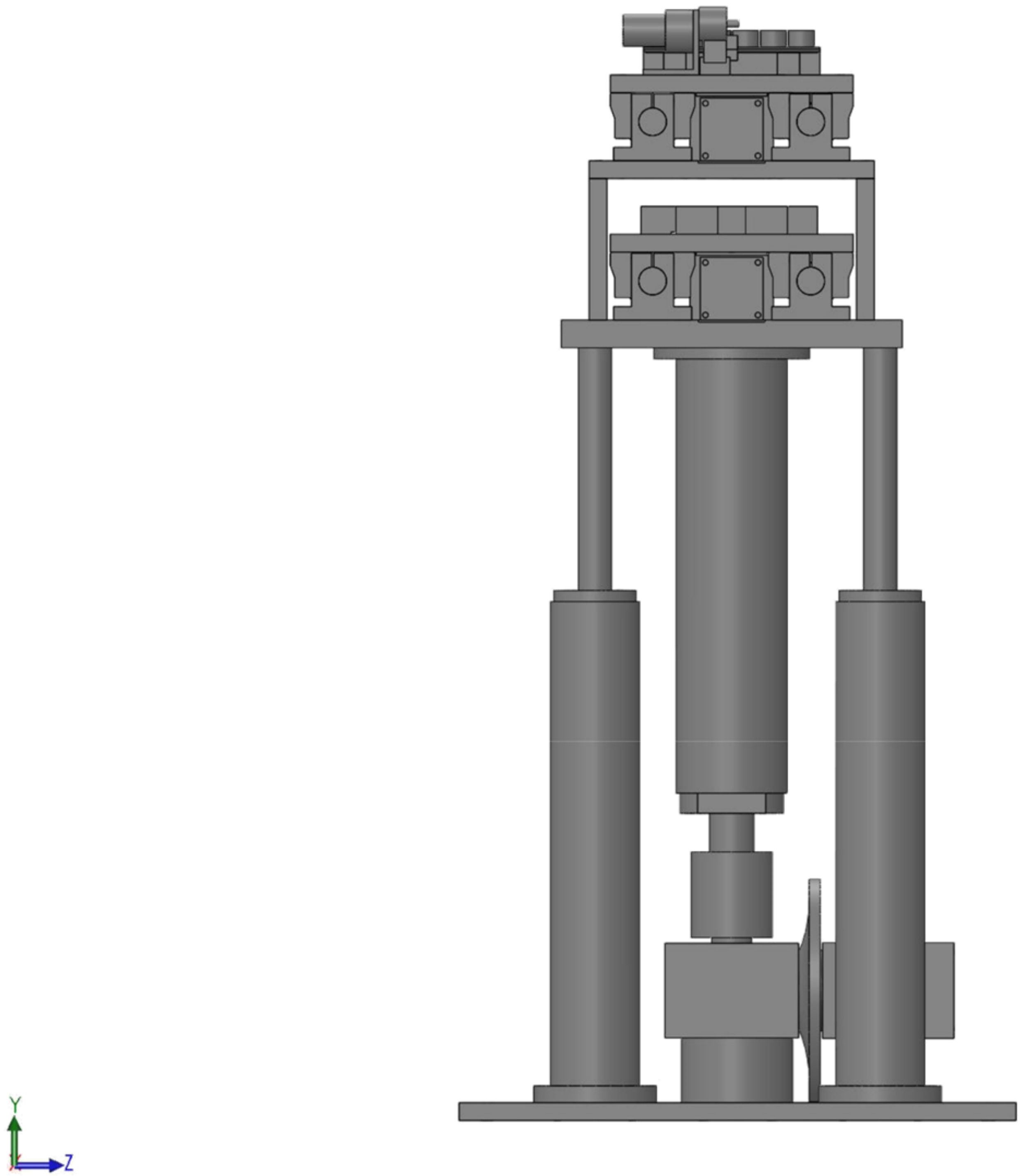

BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
Material Loading Tray
CONFIDENTIAL DRAWING
158.40
229.00
1034.99
102.00



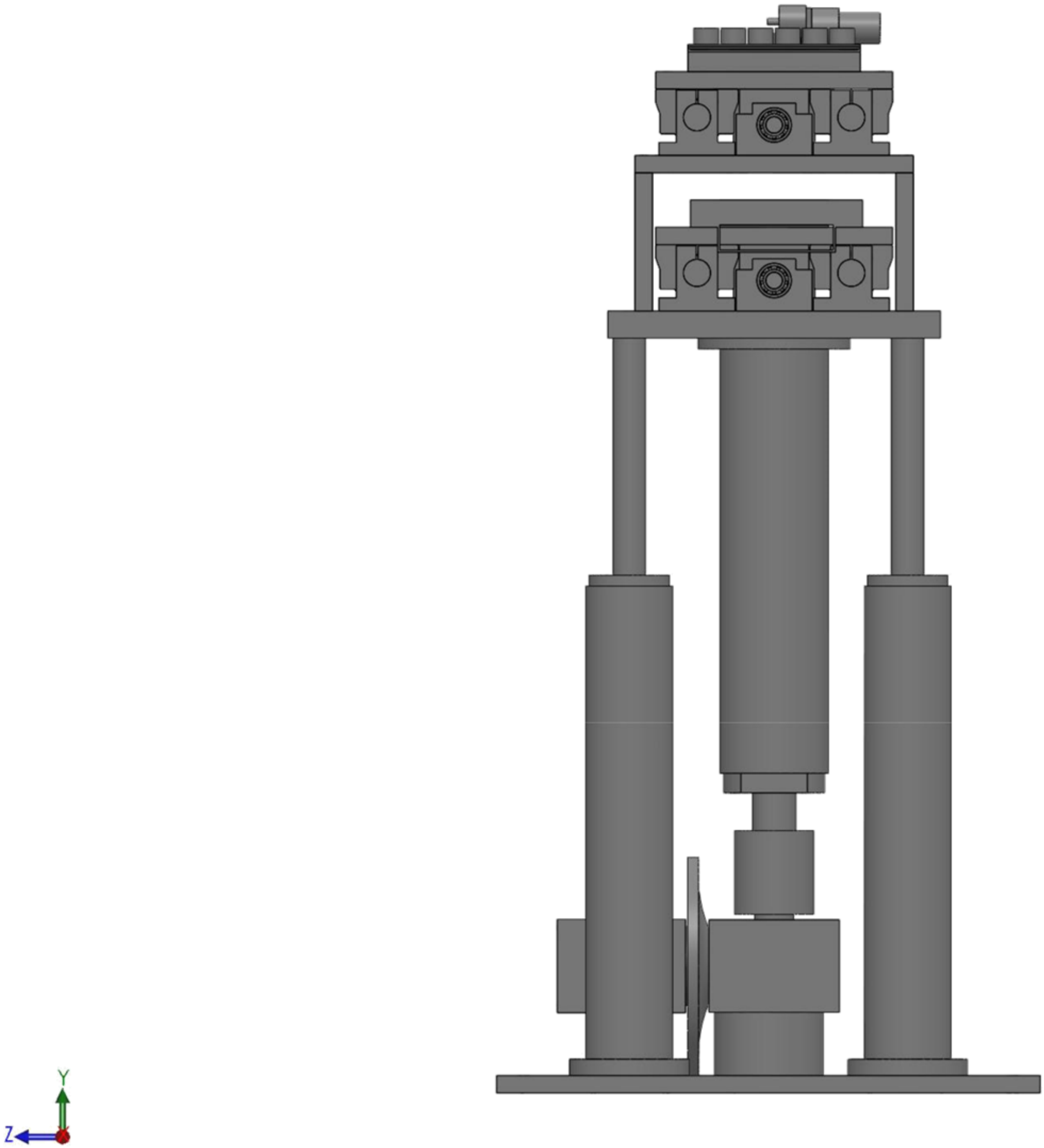
25.00
2.00
12.50
4.50
0.00
232.00
232.00
1087.78
1087.78
10.00
150.00
Material holding plate
BUREAU OF INDIAN STANDARDS
Southern Regional Office Labaratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
TITLE:
Automatic cupel and sample feeder for cupellation furnace in RAL
DRAWING NO:
BIS/SROL/AR-0084/35
REV NO:00



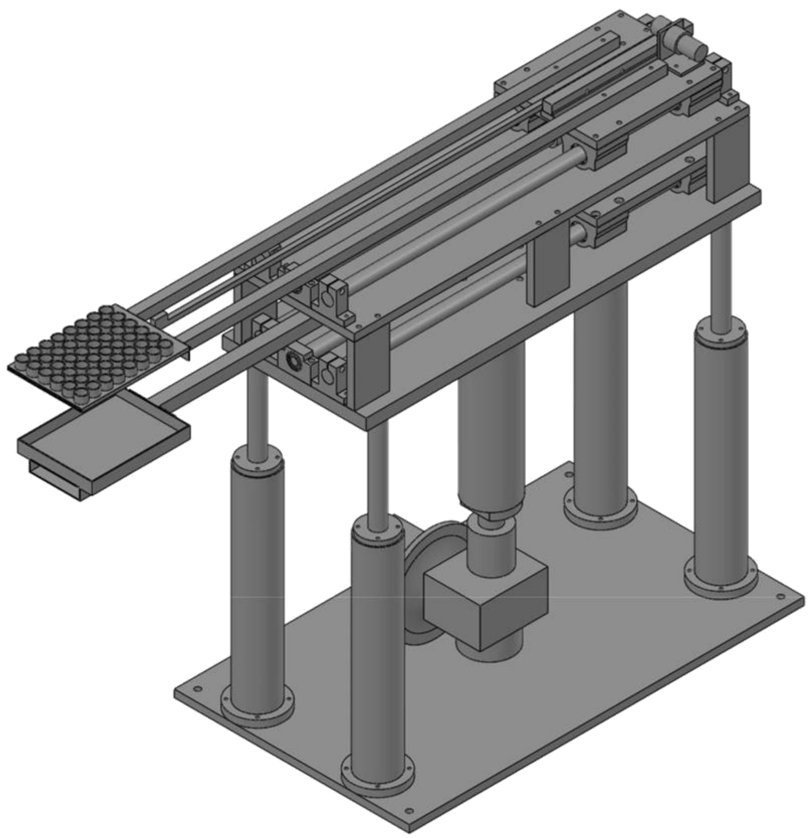
BUREAU OF INDIAN STANDARDS
Southern Regional Office Laboratory,
CIT Campus,IV Cross Road,Taramani,Chennai-600113
Automatic cupel and sample feeder for cupellation furnace in RAL
Bottom Tray Loader
209.00
1100.00
25.00



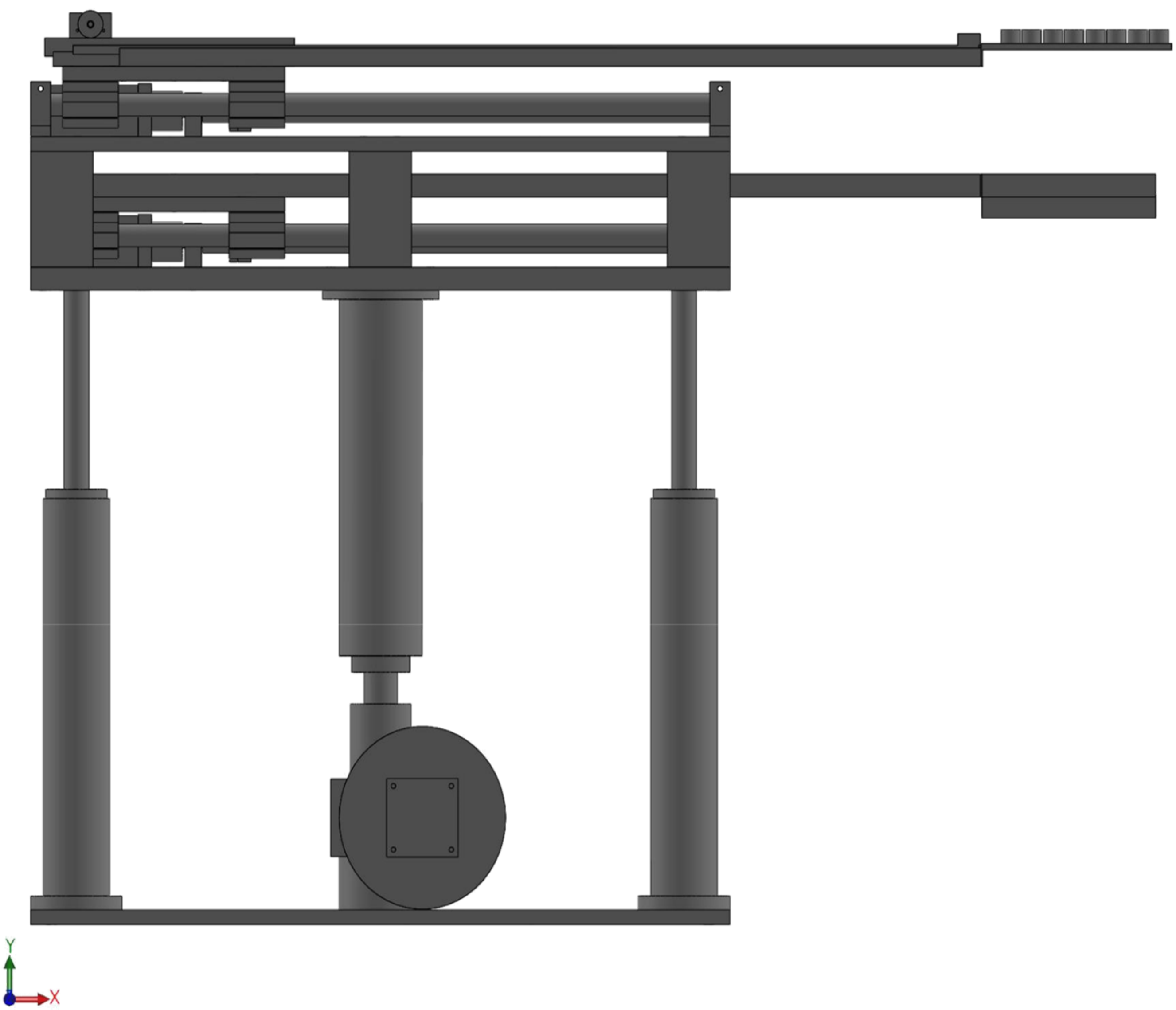
Assembly-Back



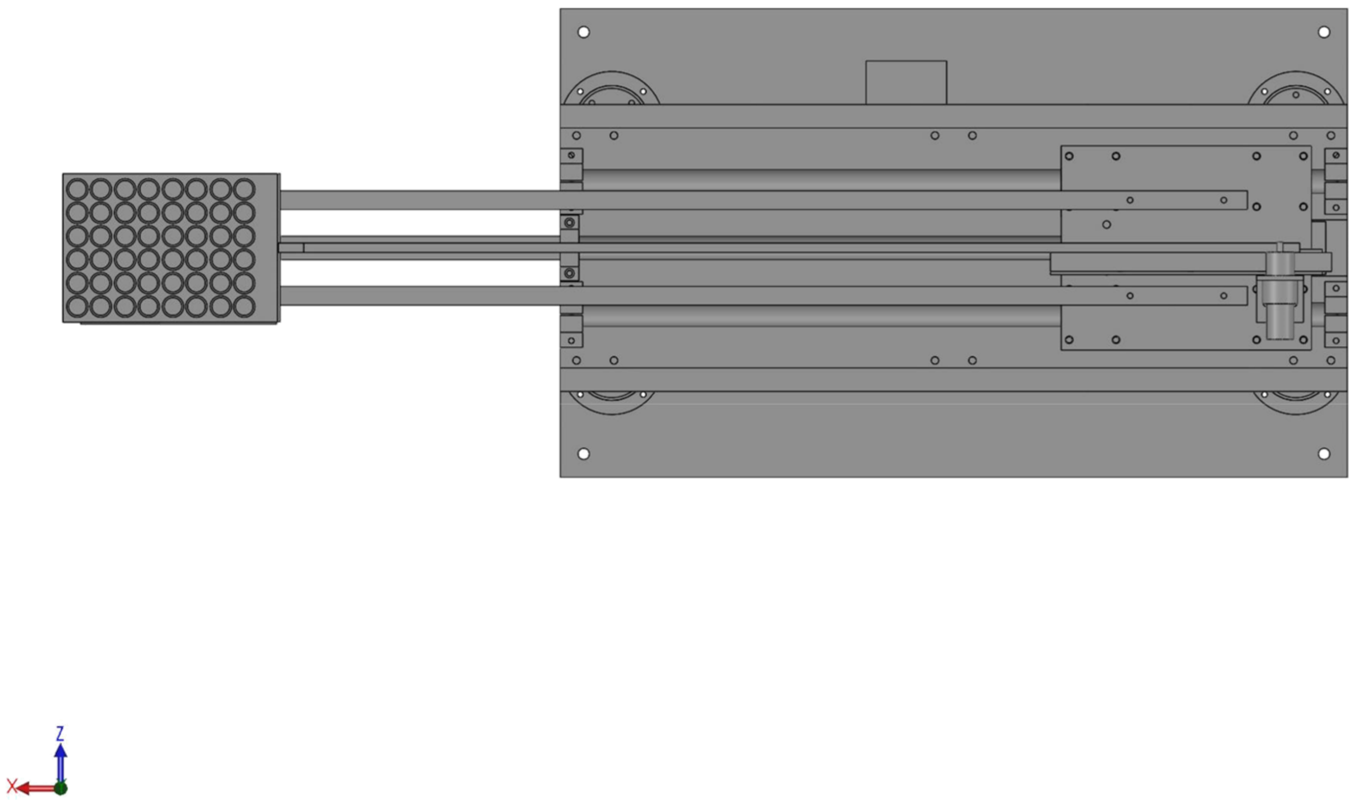
Assembly-Front



Assembly-ISO



Assembly-Side



Assembly-Top

4.4. Selection of material for parts coming into contact with furnace

- **Alloy C276** (A Nickel-Molybdenum-Chromium Alloy with Excellent Corrosion Resistance in both Oxidizing and Reducing Environments) - Heat exchangers, pressure vessels, tanks, evaporators, piping, flanges and fittings, pumps and valves.

- **Titanium Grade 2** (99% minimum titanium) - Titanium is light weight, exceptionally corrosion resistant and often exceeds the corrosion resistance of stainless steels in most environments. Titanium Grade 2 has good ductility, which allows for cold formability

Above two materials with high melting point and welding capability were checked by keeping them in the furnace for suitability for the purpose and it was observed that on Alloy C276 no scale was formed and hence found suitable for the purpose.

5. SUMMARY AND CONCLUSIONS

The present practice, proposed improvement and its advantages are as follows:

5.1 Feeding of Cuples

Present practice	Placing Magnesia Cupels into Cupellation furnace manually with help of tong. Four cupels are placed one by one and adjusted in the furnace so that there is no gap between four cupels.
Proposed improvement	Providing automatic feeding mechanism for simultaneous feeding of all cupels in the furnace.
Advantages	(i) Time required for feeding all cupels (four Nos.) simultaneously through automatic feeding mechanism will be equivalent to time required for manual feeding of one cupel, thereby reducing the time to 1/4th of the manual cupel feeding. (ii) Simultaneous feeding may enable feeding of more number of cupels (up to eight) in same time (**Figure 13**) (iii) The furnace door shall remain open for less duration and hence exposure of testing personnel to high temperature shall be reduced.

5.2 Feeding of Assay and the Proof Assay samples

Present practice	Placing the Assay and the Proof Assay samples (total 24) one by one, in cavities in Magnesia cupels, which have been preheated to 1100°C in the cupellation furnace. Cupellation of total 10 samples are done at a time.
Proposed improvement	Providing Automatic mechanism for simultaneous feeding of all Assay and the Proof Assay samples in to Cupellation furnace.
Advantages	(i) Time required for feeding all Assay and the Proof Assay (24 samples) simultaneously through automatic feeding mechanism will be approximately equal to time required for manual feeding of one sample, thereby reducing the time to approximately $1/24^{th}$ of the manual sample feeding. (ii) Simultaneous feeding may enable feeding of more number of Assay and the Proof Assay samples [20 Assay samples in duplicate (20 x 2) and 4 Proof Assay samples in duplicate (4 x 2) for 8 Cupels]. Therefore, cupellation of total 20 number of assay samples may be carried out simultaneously. (iii) The furnace door shall remain open for less duration and hence exposure of testing personnel to high temperature and toxic fumes shall be considerably reduced.

5.3 Removal of Cuples

Present practice	Removing the cupels from the furnace in the same manner in which it was placed in the furnace. Allowing the precious metal buttons to cool down before lifting them from the cupels with the assay pliers.
Proposed improvement	Simultaneous removal of all cupels from the furnace and allowing the precious metal buttons to cool down before lifting them from the cupels with the assay pliers.
Advantages	Simultaneous removal of cupels requires less time and thus the duration of exposure to high temperature and toxic fumes will be reduced.

From above mentioned advantages, it may be concluded that the Automatic feeding mechanism will achieve the aim in terms of safety, ease in operation and also in enhancing testing capacity.

5.4 Benefits to stakeholders

BIS

Testing personnel	**:**	Safety & ease of operation
RAL	**:**	Enhanced Testing Capacity (up to 1.5 times)
Standard Formulation	**:**	Standard Formulation : The equipment may be referred for guidance purpose in IS 15820: 2009 (General requirements for Competence of Assaying and Hall marking Centres)

A & H Centres

Presently A & H centres are receiving 2-3 lots in day for Hallmarking from which 2-3 samples are tested as per sampling plan. After Hallmarking becoming mandatory more samples will be required to be tested and the time equipment will enable them for enhanced testing capacity.

All

Power saving (6-7 units per batch)

6. RECOMMENDATIONS

The design/drawing may be used for fabrication of the equipment and use in RAL of BIS.

The equipment may be referred for guidance purpose in IS 15820: 2009 (General requirements for Competence of Assaying and Hall marking Centres)

7. DETAILS OF THE BIS SUPPORT AVAILED WITH JUSTIFICATION, BILLS/VOUCHERS, ETC., AS RELEVANT

For Designing of Automatic Cupel & Sample Feeder for Cupellation Furnace in RAL, drawings were also required, for which services of outside agency were taken. Total 31 drawings were got prepared, which includes drawing for complete set up and different components. Total expenditure was Rs. 14986/- (Rs. Fourteen thousand nine hundred eighty six only) on this account. Copy of bill is given below.

GST INVOICE

BaaS

Original for Buyer

BAAS TECH No 5 & 6,Temle Town Kunrathur, Chennai - 600 069 Email: info@baastech.com / baastech.chennai@gmail.com **OUR GSTIN** 33AFCPB1918H1Z2 STATE Tamil Nadu STATE CODE 33	**Invoice No.** 050 **Date** 21.12.2020 Reverse Charge (Y/N) No Transportation Mode Veh. No Date & Time of Supply Place of Supply Supplier's Ref.
Billing Address	**Shipping Address**
M/s BUREAU OF INDIAN STANDARDS Southern Regional Office Labaratory CIT Campus,IV Cross Road,Taramani Chennai-600113 State Tamil Nadu State Code 33 GSTIN No. 33AAATB0431G2ZH	**M/s BUREAU OF INDIAN STANDARDS** Southern Regional Office Laboratory CIT Campus,IV Cross Road,Taramani Chennai-600113 State Tamil Nadu State Code 33 GSTIN No. 33AAATB0431G2ZH
PURCHASE ORDER No.: SROL/3/6/2020	**DATE:** 27.11.2020

S.No	PRODUCT DESCRIPTION	HSN/SAC CODE	GST RATE	QTY	RATE	PER	AMOUNT
1	Charges for preparation of drawing for Automatic Cupel and Sample feeder for Cupellation Furnance in (RAL LAB)	4911	18%	1	Rs. 12,700.00	NOS.	Rs. 12,700.00

Sc. F & HSRGL Dy. No......347.....
Dated 23/12/2020

HSRoL
OIC(RAL)

COMPANY'S BANK DETAILS		Total Amount Before Tax	Rs. 12,700.00
Bank Name	INDIAN OVERSEAS BANK	Add : CGST 6%	Rs. 762.00
A/c Number	009833000000021	Add : SGST 6%	Rs. 762.00
Type of Account	Cash Credit (CC)	Add : IGST 0%	Rs. 0.00
IFS Code	IOBA0000098	Packing & Forwarding	Rs. 0.00
Branch	Triplicane	Transport	Rs. 0.00
Indian Rupees		Rounded Off	Rs. 0.00
		Invoice Total	**14224.00**
Fourteen Thousand Two Hundred and Twenty Four only		GST On Reverse Charge	

We declare that this invoice shows the actual price of the goods described and that all particulars are true and correct

RECEIVED THE ABOVE GOODS IN GOOD CONDITION

Customer's Signature & Seal

For BAAS TECH

CHENNAI-97

Authorised Signatory

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS

Doc. No. : PRTD/AR/**PF:04**	Issue No. : 1	Issue Date 28 Apr 2020	**DECLARATION OF ORIGINAL WORK**

DECLARATION OF ORIGINAL WORK

I, **Arvind Prakash Dhar Dwivedi, Scientist E & Head (SROL)**, Employee No. **062588** hereby declare that the Action Research Project titled "**Designing of Automatic Cupel & Sample Feeder for Cupellation Furnace in RAL**" is the original research work done by me. I have not copied from any other Action Research Project or any other work of similar nature and topic done by any person/institution/body either published or yet to be published. Data and information from other sources, used if any, have been with prior permission, wherever required and is duly acknowledged appropriately in the project report submitted by me.

This declaration is made on the 12th day of February 2021.

(A.P.D. Dwivedi)
Sc. E & Head (SROL)