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TECHNOLOGY TRAINING

FOR

MPISTC – GOA

FINAL REPORT

FEBRUARY 1998

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30p.
table
diagrams

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TECHNOLOGY TRAINING FOR MPISTC - GOA

FINAL REPORT

UNDP PROJECT NO.	-	DP/IND/91/026
REQUISITION NO.	-	96/003
UNIDO CONTRACT NO.	-	96/184
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CONTRACTOR

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SYNOPSIS

The aim of this sub-contract is to train the personnel of Metals and Plastics Industries Service and Training Centre (MPISTC) in the fields of Tool design and tool materials, heat treatment, CNC tooling and fixturing, CNC programming and CNC machine operation. The output expected of this sub-contract is to see that the recruits are trained in both theoretical and practical aspects of CNC machining and electro-discharge machining. The work plan of this sub-contract is given in Annexure - 1

CONTENTS

LIST OF ANNEXURES

1.0 INTRODUCTION

The Metals and Plastics Industries Services and Training Centre (MPISTC) is in process of establishment in Kundaim Industrial Estate by the Department of Industries and Mines, Government of Goa and the United Nations Industrial Development Organisation (UNIDO) in association with the International Labour Organisation (ILO). The centre is located about 13 Kms. North-East of Panaji, the capital of the state of Goa.

MPISTC is expected to facilitate in tackling some of the various problems faced by the Goan Industries by establishing sophisticated facilities in design and tool development, precision machining and inspection, CAD/CAM as well as in development of engineering skills. It is planned to create necessary infrastructural facilities to provide the services to the local industries in the field of consultancy in methods improvements, short-term and long-term training programs for technicians and engineers, inspection and testing of mechanical components, design and manufacture of precision tools, dies, jigs and fixtures, technical information services etc.

In order to fulfil the various tasks specified above, UNIDO/UNDP has supplied various computer hardwares and softwares and sophisticated CNC machinery (Deckel FP4 and AGIETRON 3U) to the centre aimed to establish modern Computer Aided Design/Computer Aided Machining (CAD/CAM), Production and Control (PPS), Quality Control and Assurance (CAQ) facilities at the centre for the centre's operation and demonstration to the Industries.

UNIDO has awarded a contract to Central Manufacturing Technology Institute (CMTI), Bangalore, India to provide Technology Training to the MPISTC personnel in the field of tool design and tool materials, heat

treatment, CNC tooling and fixturing, CNC programming and CNC machine operation.

2.0 SCOPE OF WORK

CMTI was expected to train the personnel of MPISTC in the field of tool design and tool materials, heat treatment, CNC tooling and fixturing, CNC programming and CNC machine operation. CMTI was to provide the services of its experts as may be necessary to MPISTC to facilitate the training of three recruits from MPISTC in CMTI for a total of nine man weeks as per the schedule given in Annexure - 1.

3.0 LIST OF MPISTC PERSONNEL TRAINING

The following eight MPISTC personnel and extreme tool & die makers trainees have been given technology training in the respective fields as shown below.

Sl. No.	Name of MPISTC Staff	Technology training given in the field of
1.	Mr. V.B. Khandeparkar	AutoCAD (Surface Modelling) NC Polaris (CNC Programming) Deckel FP4 CNC machine operation Tool presetting on Zoller
2.	Mr. D'Souza	AutoCAD (3D Surface) NC Polaris (CNC Programming) Happy CAM software (DNC operation, NC Programme transfer from PC to machine) Dialog-11 CNC (Programming) Deckel FP4 CNC machine setup and operation. Zoller tool data logging software tool materials.
3.	Mr. Jollyton	AutoCAD (3D surfaces) NC Polaris (CNC programming) Happy CAM software (DNC operation) AGIETRON 3U CNC EDM Operation 'Expertron" software (EDM programming) 'UNISET" software (EDM programming) Electrode materials EDM process technology Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping
4.	Mr. Rayman Rodrigues	Deckel FP4 CNC Machine operation Dialog-11 CNC programming Tool presetting on Zoller Tools and type of cutting materials Work alignment and clamping procedures.

5.	Mr. Depak Nazare	Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping
6.	Mr. James Vaz	Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping
7.	Mr. Suraj Adpaikar	Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping
8.	Mr. Sawanth	Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping
9.	16 Nos. Of Tool & Die makers Trainees	Tooldesign, materials & heat treatment, CAD/CAM/CAE of moulds , Jigs & fixtures, Press tools, High speed machining & Rapid prototyping

4.0 WORK PERFORMED BY CMTI

At the instance of MPISTC this task of 'Technology Training' was executed at MPISTC instead of at CMTI. CMTI experts visited MPISTC in four phases to carryout this task. It was executed parallely while executing the task of 'Productionising CNC machines" at MPISTC. This report deals with the accomplishments during the visit of CMTI experts to MPISTC. Necessary training materials were also handed over to MPISTC for their future reference (See Annexure-2 for the list of materials). The interactive exposure was given in the following topics.

4.1 Tool design and Tool materials:

- Description of cutting tool materials eg. HSS, Carbide, coated tools and CBN.
- Use of cutting tools like ball nose end mills, serrated ball nose end mills and die sinking cutters for machining dies and moulds.
- Cutting tool geometry and its details.
- Types of electrode materials used in EDM.
- Guide lines on tool design and tool materials (Tool design data).
- Types of Press tools and their construction details.
- Injection moulding for plastic components.

4.2 Materials and Heat treatment:

- Details about cutting tool materials, press tool materials.
- Plastic materials.
- Machinability of the above materials.

- Details about the commonly used mould materials e.g. High carbon High Chromium Steel (HCHC), OHNS, Hot work tool steel, P2O Material.
- Heat treatment procedure for above materials.
- Heat treatment of steel e.g. hardening, tempering, normalizing, annealing etc.

CMTI supplied necessary technical material on these topics to MPISTC for their future reference and assistance.

4.3 CNC Tooling and fixturing:

- Principles of Jigs & Fixtures.
- Work piece locating, supporting, aligning, referencing and clamping on both Deckel FP4 and AGIETRON 3U.
- Tool presetting on tool presetter 'Zoller'
- Usage of Universal Tooling System.

4.4 CNC Programming:

Necessary inputs were given to MPISTC to enable them to programme on their CNC machines, Deckel FP4 and AGIETRON 3U.

4.4.1 Deckel FP4 CNC machine:

- Manual part programming procedure was explained through Exercises.
- Inputting the programmes through MDI mode was explained.
- Programme editing, programme simulation on the screen were also given through exercises.

- Different types of tools used for machining and machining parameters were explained and demonstrated.
- Different canned cycles and subroutines provided by the CNC system were explained in detail including their usuage.
- Modelling the component using AutoCAD/Genius, generating the required tool path and NC codes using NC Polaris were demonstrated.
- Post processing the NC codes to suit Deckel/Dialog 11 and transferring the NC programme using Happy CAM to the machine through DNC interface was demonstrated.

4.4.2 AGIETRON 3U CNC EDM:

- Programming methodology using 'UNISET' was explained and demonstrated through Exercises.
- Usage of 'Expertron' to generate part programme was dealt with an example.
- Process optimization criteria was explained.
- Parallel programming i.e. programming of job No.2 while machining job No.1 was also detailed.
- EDM technology inputs given to MPISTC staff through lecture program. (Annexure-4).

4.5 CNC Machine Operation :

Deckel PF4 CNC machine and AGIETRON 3U CNC EDM were productionized by carrying out Programming, operation, and setting up of these machines with the involvement of MPISTC Staff (Mr. D'souza, Mr. Jollyton and Mr. Rodrigues).

4.5.1 Deckel FP4 CNC Machine

- Input was given to carryout machine homing, workpiece, alignment, workpiece referencing, tool length setting, dry running without tool and programme execution.
- Programming inputs like methodology of programming, programme editing, programme simulation on the screen, block by block execution, speed/feed overriding, depth of cuts etc were given to MPISTC staff.
- MDI mode of programe input.
- Proving out the programme before machining the actual workpiece on try out material.
- RS-232C serial communication link between Deckel Dialog 11 CNC system and the PC loaded with Happy CAM software was established.
- Uploading, Downloading, Reloading (Drip feed), DNC local and DNC external modes of part program transfer between the Deckel FP4 CNC machine and the PC were successfully tested.
- Typical components were machined to demonstrate various programming aids like linear offsetting, contour compensation, mirror imaging, subroutine usage, point set machining, scaling, programme interruption and continuing from the point of interruption etc. These components represented simple contour machining to complex contours, cam profiles and surface machining.
- General guide lines for operation of Deckel FP4 CNC machine was given to MPISTC Staff (Annexure-5).

4.5.2 AGIETRON 3U CNC EDM:

- Input was given regarding loading of 'UNISET' and 'EXPERTRON' softwares,

- Programming methodology using 'UNISET' and 'EXPERTRON',
- Regeneration cycle of the contaminated dicelctric fluid.
- Process optimisation, parallel programming i.e. programming of job No.2 while machining job No.1.
- Machining of typical components to demonstrate basic technological features like effect of current on surface finish, wear pattern of different electrode materials, planetary erosion, threading ,micro hole drilling etc.
- General guide lines for operation of AGIETRON 3U CNC EDM was given (Annexure-5).
- RS 232C serial communication link between AGIETRON 3U and the server PC loaded with OS2 Operating system and ISOTRON software.
- Uploading, Downloading of part programs between server PC and AGIETRON 3U were successfully tested.

4.6 Intensive on Electro discharge machining:

Theoritcal aspects of electrodischarge machining were fully dealt with by giving lectures on 'Introduction to Non-traditional machining in general and spark erosion machining in detail (Annexure-4). MPISTC personnel were trained in setting up, programming and operation of the CNC EDM. Various aspects of electro discharge machining like effect of current on surface finish, wear pattern of different electrode materials, planetary erosion, threading, micro hole drilling, cavity machining etc. Were explained.

4.7 Advanced Methods for New Product Development: (As detailed in Annexure-3)

- CAD/CAM/CAE for plastic moulds.
- High speed machining (HSM).
- Rapid Prototyping (RP)

5.0 TASK OUTPUT

The main output of this sub-contract 'Technology Training' was to see that the recruits of MPISTC are trained in both theoretical and paractical aspects of CNC machining and Electro Discharge Machining. The execution of this task was carried out in four phases. Eight recruits were trained in various fields as described above under 3.0. With the completion of this task MPISTC staff were on their own in performing the work and ready to execute their customer' requirements. Already MPISTC has started offering their services to their customers. The sample component of MPISTC customer executed in co-ordination with CMTI on Deckel is given in Annexure-6.

6.0 REMARKS AND CONCLUSIONS

The work executed by CMTI experts has been explained to the MPISTC General Manager, Cdr. P.Misra. The same has been enumerated in this report. 'Technology Training' given to eight recruits of MPISTC helped them in enhancing their technical skills in the field of tool materials, tool design, heat treatment, CNC tooling, CNC programming and CNC machine operations to render the services to their customers effectively.

7.0 ANNEXURES

27/08/96

Sub Contract for "In country Training" of Project Personnel from Project DP/IND/91/026 MPISTC, Kundaim, Goa, at CMTI, Bangalore

Work plan of technology training

Annexure - 1

--> in days

Sl.	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Tool Design & Tool materials																			
2.	Materials and heat treatment																			
3.	CNC Tooling and fixturing																			
4.	CNC Part Programming																			
5.	CNC Machine Operation																			
6.	Intensive on Electrodischarge machining																			

Annexure - 2

LIST OF TRAINING MATERIALS HANDED OVER TO MPISTC

1. Tool Design data

2. Calculation procedure for design of plastic moulds

3. Mould material details for press tools, jigs and fixtures and Plastic moulds

4. Design procedure for Press tools

Annexure - 3

Advanced methods for new product development

CAD/CAM/ CAE for plastic moulds.:

Explained the advantages of CAD/CAM/CAE as applied to plastic mould design. Traditional mould manufacturing methods are considered to be largely an art. This was explained in detail how moulds are made right from component design and manufacturing of core and cavity (the template for core and cavity made by an artist) using copy milling machines. Design of runner, gate and cooling system by the past experience of designer. Non application of scientific methods leads to poor quality moulds and as a result bad mouldings.

Advantages of Computer Aided Design compared to traditional drafting process was explained in detail. The advantages of design, modification, storage and retrieving of drawing in CAD system and use of standard mould element data base(HASCO, DME) in reducing the lead time was explained in detail.

Computer Aided Manufacturing (CAM) electronically captures part and communicates this information to manufacturing equipment such as robots and Numerical Control machines which produce accurate parts with minimum labour. This was explined in detail by giving the constructional features of CNC machine i.e. the precision elements such as Ball Screw, LM guides and control system and drives & motors.

Computer Aided Engineering i.e. Process simulation softwares such as C-MOLD and MOLD FLOW as applied to injection moulding was explained in detail. The capabilities of these softwares in designing gate, runner and cooling system and the analysis outputs such as melt front advancement, air traps, pressure curves, temperature curves, shrinkage and warpage was explained in detail.

High Speed Machining (HSM) and Rapid Prototyping (RP):

The need of the hour is to deliver quality moulds in the shortest possible time. To achieve this, the importance and capabilities of HSM and RP techniques were explained in detail.

High Speed Machines equipped with high rpm spindles (15,000 to 100000) with high feed rates of 40 to 50 m/min cutting hardened material (above 50 HRC) was explained.

The importance of Rapid Prototyping tecniques in the development of prototypes and patterns was explined. With Rapid Prototyping technology, patterns, prototypes and casting moulds can be produced immediately . CAD/CAM data generated on computer, is realised by rapid prototyping machines such as Stereo-lithography, Laminated Object Manufacturing (LOM) and Fused Deposition Modelling (FDM).

EDM TECHNOLOGY

Introduction :

Many of the recent developments in aerospace and nuclear engineering are due to the increasing use of difficult to machine materials such as super alloys (hastalloy, nitralloy, waspalloy, nimonics), titanium and its alloys, carbides, stainless steels and other refractory alloys. These materials are characterised by their

- High strength to weight ratio enabling fabrication of parts that are light in weight but are of comparable strength.
- High hardness.
- Excellent fatigue strength.
- Capabality to withstand high temperature.

Although the above properties are highly desirable from the point of functional performances, difficulties are encountered in machining these materials to the required geometrical shapes and tolerances. The conventional machining processes, inspite of technological advancements, are inadequate to machine these materials economically. Besides, machining of these materials into complex shapes is difficult, time consuming and some times impossible.

Several sucessful machining methods which are termed as "Non-Traditional Machining Processes" have emerged to offer solutions. These non-traditional machining methods differ from the generally understood machining practice as regards mechanics of material removal. In conventional machining, removal of work material is effected when a cutting tool comes in contact with the work pieces. On the other hand, in non-traditional machining processes the material removal is effected through a physical or chemical phenomena. The material is removed over the full area of the work piece. The work surface is machined with a pattern that is essentially non-directional as compared to the regular and directional metal removal in conventional machining methods.

The applications of non-traditional machining methods may be thought of as an alternative to conventional machining processes when the following situations are encountered.

(a) Difficult to machine materials because of their

- high strength.
- high hardness.
- abrasive quality.

(b) Complexity of shape.

(c) Difficult to handle jobs such as aircraft bodies, wings etc.

(d) Micromachining and fine detailing.

(e) Machining of distortion sensitive materials.

(F) Fragile workpieces that are sensitive to distortion and/or donot withstand cutting forces.

(g) Requirement of accurate form and size tolerances.

Non-traditional machining processes can be basically classified into three main categories depending upon the type of primary energy mode used to effect material removal. They are:

1. Thermal and Electro thermal.

2. Chemical and Electro-chemical.

3. Mechanical.

Classification of Non-traditional machining processes

Type of energy	*Mechanism of metal removal*	*Transfer media*	*Energy source*	*Processes*
Mechanical	Erosion	High velocity particles	Pneumatic/ hydraulic pressure	**AJM, USM, WJM**
Electrochemical	Ion displacement	Electrolyte	High current	**ECM, ECG**
Chemical	Ablative relation	Reactive environment	Corrosive agent	**CHM**
Thermoelectric	Fusion	Hot gases	Ionised material	**IBM, PAM**
		Electrons	High current	**EDM**
	Vapourisation	Radiation	Amplified light	**LBM**
		Ion stream	Ionised material	**PAM**

AJM : Abrasive Jet Machining
CHM : Chemical Machining
ECG : Electrochemical Grinding
ECM : Electrochemical Machining
EDM : Electro-discharge Machining
IBM : Ion Beam Machining
LBM : Laser Beam Machining
PAM : Plasma Arc Machining
USM : Ultrasonic Machining
WJM : Water Jet Machining

Electric Discharge Machining

Of all the Non-traditional machining processes, electric discharge machining (EDM) is,undoubtedly, the most widely used in production as well as in tool-rooms.

In the EDM process, material is removed by a series of discrete electrical discharges (sparks) that occur in the machining gap between the electrode and the workpiece. The dielectric fluid between the electrode and the workpiece creates a path for the discharge as the fluid becomes ionized between the two closest points. The initiation of the discharge occurs when sufficient voltage is applied across the machining gap to cause the dielectric to ionize and current to start to flow.

Parts of EDM machine:

1. Basic machine.
2. Generator.
3. Dielectric unit.
4. CNC control system.

Applications of EDM:

Electrical discharge machining is used in the manufacture of following dies and moulds.

1. Stamping dies.
2. Extrusion dies.
3. Diecasting and forging dies.
4. Wire drawing dies and moulds.

Electrode

Functions of electrode material are:

- To convey the electrical machining pulses to allow the erosion of workpiece to take place with little or no wear of electrode.
- To produce the shape of electrode on work piece.

Selection of electrode material

Material	Wear ratio	Material Removal Rate (MRR)	Fabrication	Cost	Application
Copper	Low	High on rough range.	Easy	High	On all metals.
Brass	High	High only on finishing range.	Easy	Low	On all metals.
Tungsten	Lowest	Low	Difficult	High	For drilling small holes.
Tungsten - Copper alloys.	Low	Low	Difficult	High	Used for higher accuracy work.
Steel	High	Low	Easy	Low	For finish work.
Zinc based alloys.	High	High on rough ranges.	Easily diecasted.	Low	On all metals.
Graphite	Low	High	Very delicate, hence difficult.	High	On all metals.

Functions of dielectric fluid:

- The primary function of dielectric fluid is to concentrate the energy by enabling a narrow ionization channel to be built across spark gap.
- It should deionize rapidly after the spark diacharge has taken place.
- The dielectric fluid should have sufficient and stable dielectric strength to serve as insulation between the electrode and tool.
- It should have low viscosity and a good wetting property.
- Should be chemically neutral so as not to cause damage to the electrode, work, machine elements and operator.
- Its flash point should be sufficiently high to avoid any fire hazard.

Recommended commercial grade dielectric fluids

Brand	Viscosity at 20 degree celcius	Flash point
	Cst	degree Celcius
1. BP Dielectric 20	6.0	120
2. Castrol HONICO 409	6.4	135
3. ESSO MENTOR 20/ SOMENTOR 43	7.4	124
4. ESSO LECTOR 40	6.8	132
5. MOBIL OIL VELOCITE 4	9.0	118
6. MOBIL OIL VELOCITE 6	19.1	158
7. WHITE SPIRIT (Kerosine)	2.0	78

The choice of any particular dielectric depends on the workpiece size, complexity of shape, tolerance, surface finish and the material removal rates. The following guide lines may be used in selecting hydrocarbon dielectric fluid for:

- Machining of large parts : Oil of viscosity 12 to 20 Cst.
  (Surface finish 6.3 Ra and above)
- Machining of medium size parts : Oil of viscosity 6 to 12 Cst.
  (Surface finish 0.8 to 6.3 Ra)
- Machining of small parts : White spirit, Kerosene.
  (Surface finish 0.4 to 1.2 Ra)

Guidelines for operation

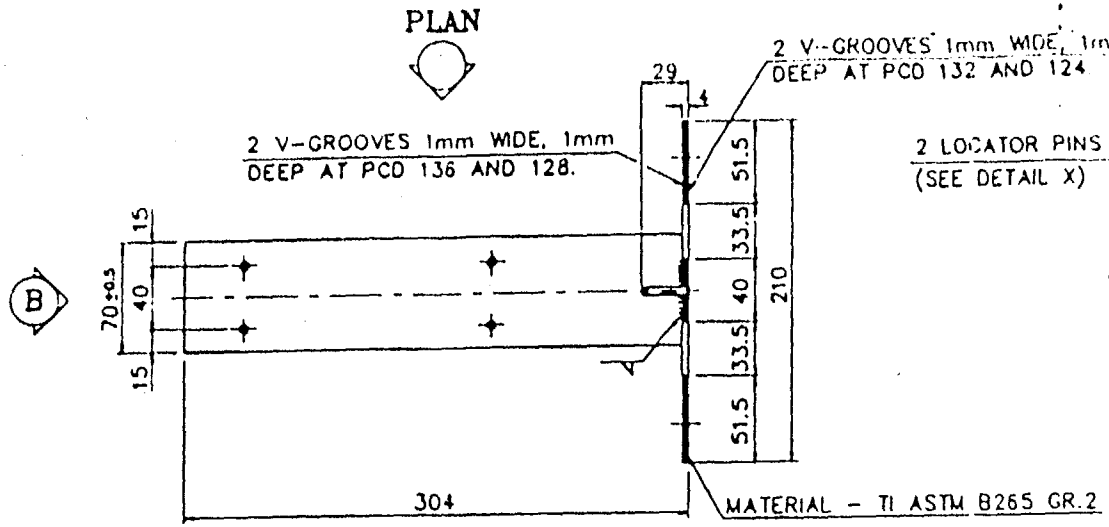
DECKEL

- Study of the component and assessing the programming methodology.
- Programming the component as per the decided methodology.
- Transfer of programme to the control system in case of offline approach. In Off-line programming method, the CAD is used to model the component and CAM to generate NC programme.
- Premachining of references on the component.
- Adopting suitable work holding method (special fixtures if required) considering the cutting forces and the job intricacies.
- To establish the work piece. origin and the programme reference with reference to machine datum (use appropriate G codes).
- To perform dry run of the loaded CNC programme and check the major deviations in axis movements and axis limits.
- Prepare the tool list as per the CNC programme.
- Pre-set the tools as per the list.
- Tool data input to the system.
- In the absence of roughing programming cycle, verify the amount of stock on the work piece.
- In the case of complex shaped components, prove the programmes by machining on tryout materials like WOOD/WAX/FOAM.
- First piece machining can be carriedout with over riding the speed/feedrate programmed appropriately.
- Inspection of the first piece and analyse the deviations.
- Incorporate the changes if any and generate the final CNC programme accordingly.
- Productionizing the component.

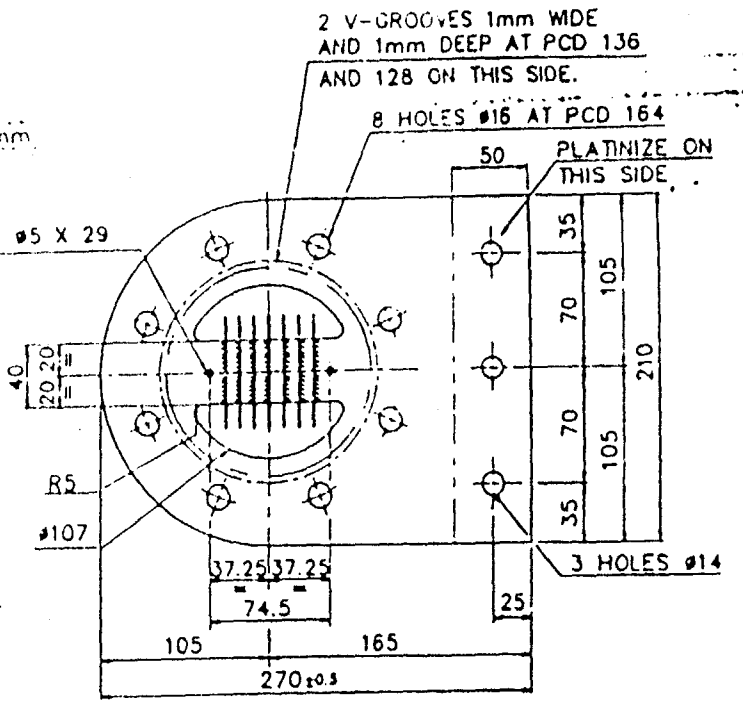
AGIETRON

- Study of the component requirements.
- Plan for the roughing/semi-finishing/finishing cycles.
- Design the electrodes for the above (including type and quantity) considering spark gap.
- Machining of electrodes.
- EDM process parameters selection according to the machining cycles.
- Preparation of CNC programme using UNISET/EXPERTRON for the above machining cycles.
- To establish the W.P. origin to generate references.
- To machine the component as per the selected cycle and if necessary by over riding process parameters appropriately.
- Inspection of the part and analyse for deviations.
- Inspection of the part and analyse for deviations.

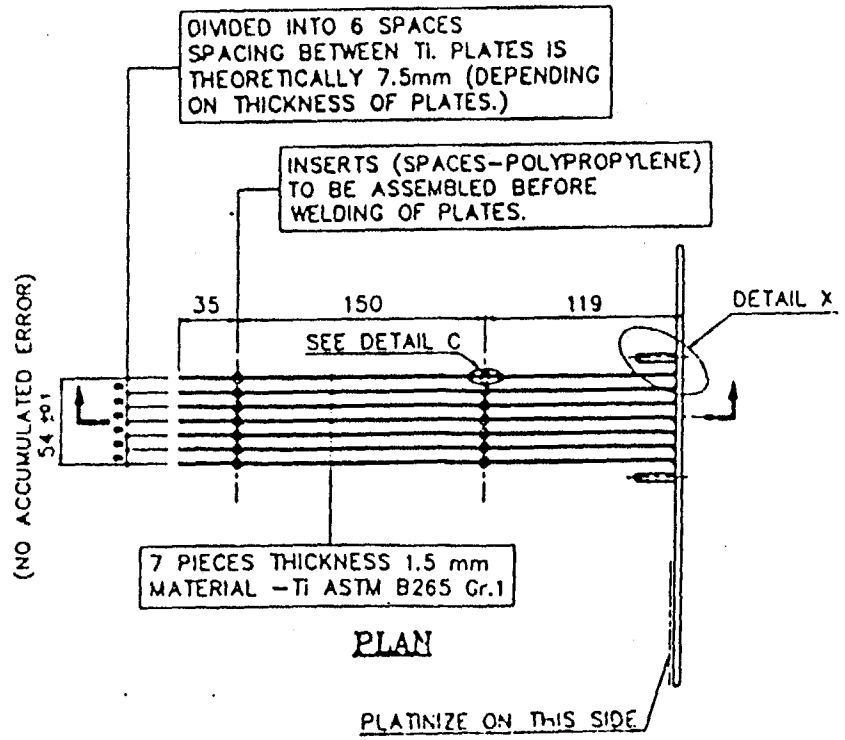
Sample component of MPISTC customer



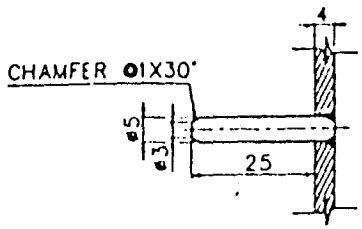
SECTIONAL ELEVATION



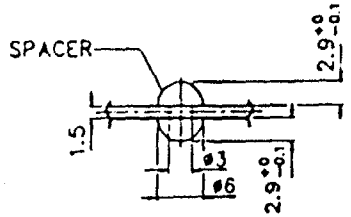
VIEW B



PLAN



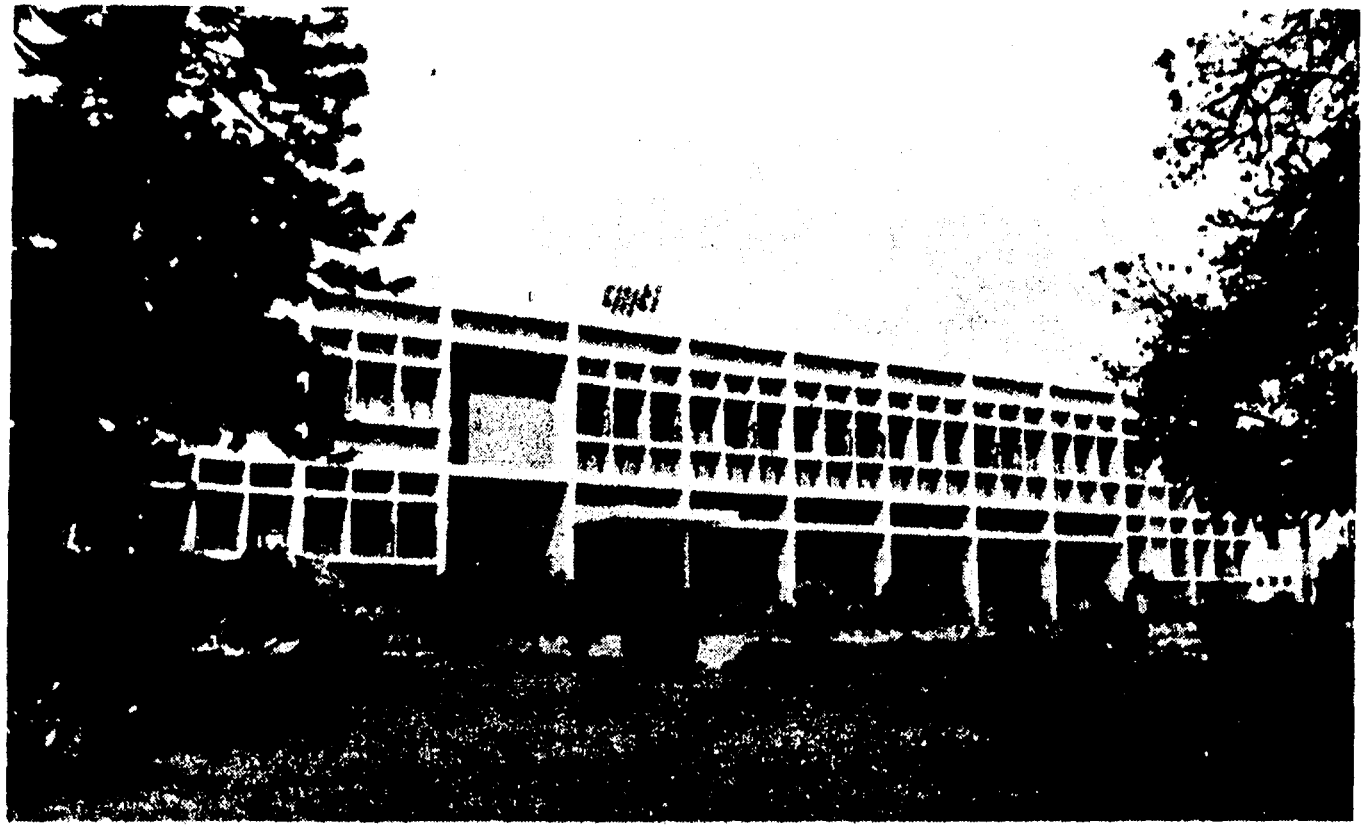
DETAIL X
(LOCATOR PIN)
SCALE : 1 : 1



DETAIL C
SCALE : 1 : 5

POS.: 2
CATHODE HEAD
MATERIAL: Ti ASTM B265 Gr.1 & GR. 2
QUANTITY: 1 pc
UNIT WEIGHT:
MARK: ⊖

Annexure-6



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