

## DESIGN BRIEF

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Project : **Proposed UP Department of Mining, Metallurgical and Materials Engineering Building (MMME Building)**

Location : **National Graduate School of Engineering Complex  
University of the Philippines Diliman**

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### I. Introduction

The proposed infrastructure development for the University of the Philippines Department of Mining, Metallurgical and Materials Engineering comprises two (2) separate buildings: the Main Building and the Pilot Plant.

The Main Building is to be a three-storey reinforced concrete structure with a total floor area of approximately 3,000 square meters. It will accommodate the administration facilities, lecture rooms and laboratories of the MMME Department.

The Pilot Plant is to be a three-storey reinforced concrete structure with a total floor area of approximately 1,500 square meters. It will accommodate the various teaching laboratories of the MMME Department. The first floor shall have a double height ceiling to contain large sensitive equipment.

All buildings shall have an automatic fire suppression system (sprinklers) and proper acoustic treatments of various areas particularly the lecture rooms and laboratories. All buildings shall incorporate energy-efficient design concepts particularly in lighting, cooling and ventilation. All buildings shall incorporate security management systems. Laboratories shall be provided with efficient exhaust system, solid and liquid waste collection, gas and chemical distribution, as well as hazard and safety features.

The approximate total cost for all buildings is Php 120,000,000.00. Due to availability of funds, the subsequent construction of the MMME Buildings shall be phased. The budget allotted for each phase in construction shall be provided by the University of the Philippines at a later date. Each phase shall result in buildings or portions of buildings that are safe and substantively operational to allow functional occupancy by the MMME Department. The scope of work to be accomplished at each phase shall be within the budget specified.



## II. List of spaces

Spaces to be included for each building are as follows:

### a. Main Building

#### i. Laboratories

1. Clean Room
2. Thermal Analysis Room
3. Electron Microscope Laboratory
4. XRD/AAS/SMA Room
5. Substrate Processing Room
6. Sample Preparation Room
7. Optical Microscopy Room

#### ii. Other Spaces

1. Classrooms / lecture rooms
2. Conference Room
3. Administration Office
4. Department Chair's Office
5. Faculty Lounge / Meeting Room / Library
6. Faculty Offices
7. Audio-Visual Room
8. DIGRI Room

#### iii. Circulation and Ancillary Spaces

1. Stairs
2. Lobbies, hallways and corridors
3. Restrooms
4. Electrical Rooms
5. Storerooms
6. Janitor's closet

### b. Pilot Plant

#### i. Laboratories

1. Mineral Processing Laboratory
2. Extract Metallurgy Laboratory
3. Adaptive Metallurgy Laboratory
4. Ceramics Laboratory



5. Composites Laboratory
  6. Surface Science Laboratory
  7. Dark Room Facility
  8. MSMRL
  9. Datamine Facility
- ii. Other Facilities
1. Computational Room
  2. Discussion Room
  3. Classrooms / lecture rooms
  4. Student Lounge
  5. Exhibition Hall
- iii. Circulation and Ancillary Spaces
1. Stairs
  2. Lobbies, hallways and corridors
  3. Restrooms
  4. Electrical Rooms
  5. Storerooms
  6. Janitor's closet

### III. Description of Spaces

Please refer to Annexes A-G for more detailed requirements of each space (such as furniture and equipment needs)

#### *Classrooms*

Two types of classrooms are required: 30-seater and 60-seater capacity. All classrooms shall have windows at opposite walls, ensuring proper cross-ventilation within the room. All classrooms shall have proper acoustic treatments. Provide adequate insulation from possible exterior noise and minimize acoustical defects within. All classrooms shall have provisions for future installation of air-condition units.

Second floor classrooms located at the Main Building shall have provisions for conversion into laboratories (confirm height and column spacing requirements). Utility lines shall be installed for future use.

#### *Laboratories*

All laboratories shall have utility lines (electricity, structured cabling/communications, water and gas) laid out for easy customization and future tapping. Gas lines for three types (oxygen, nitrogen and argon) shall be conveniently laid out. They shall be accessible and exposed for possible detection of



leaks, but protected from accidental impacts and harm. Provide conduits for the gas lines to gas tank rooms with a pipe shaft at the ground floor. The gas tank room shall be easily accessible to deliveries.

Several laboratories shall be more than one storey high (1.5 up to 2.0 storeys). Provide such laboratories with large windows to mitigate heat and dust, stretching from at least one meter above the floor to the ceiling of the floor above (this assumes the laboratories shall be airconditioned at the outset since dust will collect if the windows are left open). Provide window grills or other alternatives for security purposes.

All laboratories shall have provisions for air-condition units. All laboratories shall have proper acoustic treatments. Provide adequate insulation from possible exterior noise and minimize acoustical defects within.

Finishes for laboratories shall be stain-resistant, chemical resistant, resistant to dust collection, and easily maintained. For specifics regarding each type of laboratory, refer to Annex C.

#### *Audio-Visual Room*

The Audio-Visual Room shall have a capacity of 100 occupants. The Audio-Visual Room shall have a proper acoustical design with appropriate treatments of surfaces. For rooms of speech such as the Audio-Visual Room, the acoustical requirements shall be as follows:

1. There should be adequate loudness throughout.
2. Sound energy within the space must be diffused.
3. Space must have an optimum reverberation time.
4. Space must be free from acoustical defects.
5. Noise and vibration must be avoided.

The sound system shall be incorporated into the design. Speakers shall be recessed and lines concealed.

A lobby and sound lock shall be provided at the entrance of the Audio-Visual Room. The lobby shall have adequate space for a registration area and traffic of the room users. The Audio-Visual Room shall also have a control room for the technician and audio-visual equipment. The control room shall also serve and be adjacent to the DIGRI room. The Audio-Visual Room shall have a stage, flexible and large enough for conferences and performances. All utility lines shall be concealed. (shall the floor be flat or inclined?)

#### *Department Chair's Office*

The Department Chair's Office shall be adjacent to the Administration Office. The Department Chair's Office shall be provided with an exterior waiting area and a private toilet with a shower stall (what about a bed?). The Department Chair's Office shall have a conference area for a small group. Finishes shall befit the status of the occupant.

#### *Administration Office*

The Administration Office shall be for the use of three (3) administration personnel and two (2) student assistants. The Administration Office shall contain a reception area for visitors and a small pantry for the staff's and the director's use.

#### *Faculty Offices*

The Faculty Office shall have provisions for 30 faculty members. Space for a small consultation table for two (2) for every five (5) faculty shall be provided. The Faculty Office shall have its own toilet with shower stalls for male and female. (dry locker areas for clothes & documents?)



#### *Faculty Lounge / Meeting Room / Library*

The Faculty Lounge shall have a pantry and dining area. The Faculty Lounge shall also contain a library. The Faculty Lounge shall be a venue to hold meetings and for the exclusive use of the faculty.

#### *Student Lounge*

The Student Lounge shall have provisions for 30 students. The Student Lounge shall contain a locker area.

#### *Exhibition Hall*

The Exhibition Hall shall be a large and flexible space to hold exhibits and displays. The Exhibition Hall shall have a proper lighting system for display purposes.

#### *Conference Room*

The Conference Room shall hold a maximum of 25 occupants. The Conference Room shall have a projection wall for presentations. The Conference Room shall have proper acoustic treatments. Provide adequate insulation from possible exterior noise and minimize acoustical defects within. The Conference Room, if possible, shall be adjacent to a pantry.

#### *DIGRI Room*

The DIGRI (what does the acronym stand for?) Room is a special type of lecture room wherein video cameras are installed to record lectures and presentations. Provide lighting and acoustics systems appropriate for this use. The DIGRI Room shall have a maximum capacity of 30 occupants. The DIGRI Room shall be adjacent to the control room.

#### *Circulation and Ancillary Spaces*

Major corridors shall have a minimum width of 2.50m (is this clear width?; also, 2.50 is not modular, maybe 2.40 or 2.44 better, let Leo decide). Major stairs shall have a minimum width of 2.5m (clear distance?). Minor stairs shall have a minimum width of 1.50m (clear distance?, please check with Fire & Building Codes).

Entrances and exits shall follow accessibility standards. All buildings shall have provisions for fire exits. Exterior fire escapes or ladders are not permitted.

Male and female comfort rooms shall be provided at each floor. A handicap stall shall be required at least for the ground floor. Installed toilet fixtures and accessories shall be of the water-saving type (could they also mean waterless? a waterless system is also expensive to operate/maintain). Provide space for a janitor's closet at each floor. Each floor shall have an electrical room sufficient in size and accessible for maintenance purposes.

#### **IV. Description of the Site**

The site is located at the corner of C.P. Garcia Avenue and Velasquez Street. The site is part of the National Graduate School of Engineering Complex. Please refer to Annex J. The site has an area of 9.3 hectares with an irregular shape. Roads in subsequent phases of development shall traverse the south and east side of the site. Pedestrian walkways and access shall be located at the north and northeast side. The proposed CE building bounds it at the west.



Due to the constant traffic and noise of CP Garcia, a setback of at least 8 meters from the boundaries of the site shall be maintained.

## V. Requirements for Site Development

The following items shall be reflected in the design of the site development plan:

1. pedestrian pathway to and around the building (to be linked to the planned pedestrian walkway of the Engineering complex – need the overall plan)
2. covered drop-off or driveway for visitors for both buildings linking to the planned peripheral road of the Engineering complex – need alignment of this peripheral road
3. parking area for at least 40 cars, easily accessible from the drop-off (any covered parking requirement?)
4. secondary entrance for delivery purposes easily accessible to the labs for both buildings with adequate space for hoisting equipment to upper floors
5. proper location of the following:
  - a. generator set house located away from an appropriate distance from the buildings
  - b. service entrance and transformer
  - c. septic tank and wastewater processing and special chemical waste handling
  - d. water tank and/or cistern and fire reserve or rainwater compartment
  - e. pump house
  - f. garbage disposal receptacle
  - g. building signage
6. proper landscaping with the preservation of existing trees a priority and plants requiring minimal degree of maintenance (is landscaping part of the PTCC contract? Is interior and furniture design also part of the PTCC contract?)
7. proper outdoor lighting for the pathways and parking area, including night lighting for the buildings (using energy-saving lighting fixtures and bulbs)
8. designation of expansion area for future developments
9. proper site drainage and storm sewer layout

Pathways, driveways, parking spaces and other concrete surfaces shall have perforated and porous surfaces to induce natural rainwater runoff (to feed the rainwater collector system) and reduce radiant heat within the site (we use pavers, asphalt, sand and gravel for all paved areas)

## VI. Codes and Standards

The PROJECT shall be designed, engineered, installed, tested, commissioned and turned over in conformity with the general policies of the University of the Philippines and with the latest editions of the National Building Code of the Philippines (the 2004 Revised IRR that took effect on 01 May 2005), the National Structural Code of the Philippines, the Philippine Electrical Code, the National Plumbing Code of the Philippines and other relevant codes and standards.

## VII. Green Building Concepts

### *Energy Efficiency*

The reduction of energy consumption shall be incorporated in the buildings' electrical design. The target operational energy usage shall be at least 20% less as opposed to conventional electrical design. (please research/ refer to Department of Energy guidelines)

The following are suggested methods that may be incorporated in the design, though the designer is not restricted to them. Furthermore, the designer is encouraged to introduce more alternative and creative ways to achieve energy efficiency.



1. Passive cooling techniques – Prevent heat gain of interior and exterior spaces to reduce mechanical cooling loads, by proper orientation of building, material specifications, use of sunshading (sunbreaker) devices, green roofs (I hope they do not mean a garden roof) and others. Induce sufficient airflow to public areas and spaces that do not require mechanical cooling (lobby, corridors, classrooms, etc.)
2. Daylighting techniques – Reliance on daylight to achieve ideal lighting conditions for spaces at daytime. Minimize lighting fixtures and proper switching layout and locations of fixtures to reduce electrical load. Specify lighting fixtures with energy-saving features.
3. Alternative energy sources – Introduce off-grid energy sources such as solar panels and wind turbines, factoring initial procurement cost in the overall budget. (ok, but when must they come onstream in the Project implementation or building occupancy timeline?)

#### *Water Conservation*

The reduction of water consumption shall be incorporated in the buildings' mechanical design. The target operation water consumption shall be at least 20% less as opposed to conventional mechanical design.

The following are suggested methods that may be incorporated in the design, though the designer is not restricted to them. Furthermore, the designer is encouraged to introduce more alternative and creative ways.

1. Waste water recycling – Re-use wastewater from lavatories and kitchen sinks for flushing and watering of plants.
2. Efficient toilet fixtures – Specify toilet fixtures (water closets, urinals, faucets, shower fixtures, etc.) that consumes less water than conventional standards.
3. Rainwater collection – Encourage the collection of rainwater at special cisterns (with year-round maintenance provisions) for non-potable consumption of water such as flushing and watering of plants.
4. Resilient greenery – Specify plants for the site development that require minimal watering and maintenance.

#### *Green-Building Materials*

As much as possible, green-building materials shall be specified in the design. Green-building materials are environmentally responsible materials whose impacts are considered over the life of the product. Green building materials have the following desirable qualities.

1. containing recycled content
2. raw materials from natural, renewable and plentiful sources
3. locally available or requires only a short distance for procurement
4. recyclable and reusable including its packaging material
5. durable and does not require frequent replacement or reapplication
6. efficiently manufactured in terms of energy, water and by-products
7. non-toxic to its intended users and in its manufacturing and construction process

### **VIII. Suggested Layout**

Please refer to Annex H for the drawings displaying the suggested layouts for the main building and pilot plant of the MMME complex. The drawings reflect the proximity and zoning of the spaces as preferred by the end-users and the distribution of spaces for each level. The dimensions and area of each space are approximate to the requirements of the end-users. However, it shall not be construed



as final and perfect, but as a starting point for the consultants to develop their own design. The consultants are encouraged to propose a more responsive layout and configuration.

Please refer to Annex I for the suggested layout of the laboratories regarding the placement of equipment and utilities, interior partitions and other special facilities.

**IX. Space Requirement**

The tables on the following pages list the space requirement of each building and floor. The suggested location of each space is ideal but shall not be interpreted as final. The projected floor area for each space is the minimum requirement.

Spaces	Quantity	Projected Floor Area (sq.m) (Minimum requirement)	Projected Total Floor Area (sq.m) (Minimum requirement)
<b>Main Building <u>(need to confirm which shall have airconditioning at startup/occupancy &amp; which shall have airconditioning later?)</u></b>			
<b>First Floor</b>			
1 Clean Room	1	200	200
2 Thermal Analysis Laboratory	1	40	40
3 Electron Microscopy Laboratory	1	80	80
4 X-ray Laboratory	1	80	80
5 Substrate Processing Laboratory	1	120	120
6 Sample Preparation Laboratory	1	80	80
7 Optical Microscopy Laboratory	1	40	40
8 Comfort Room	1	40	40
9 Electrical Room and Utility	1	40	40
10 Lobby	1	40	40
11 Circulation Space (stairs, hallway, etc.)			240
<b>Total for 1st Floor</b>			<b>1000</b>
<b>Second Floor</b>			
1 Library/Faculty Lounge/Meeting Room	1	80	80
2 Administrative Office	1	40	40
3 Department Chairman's Office	1	40	40
4 Faculty Room (30 pax capacity)	1	160	160
5 Classrooms (60 pax capacity)	3	80	240
6 Classroom (30 pax capacity)	1	40	40
7 Conference Room	1	40	40
8 Comfort Room	1	40	40
9 Electrical Room and Utility	1	40	40
10 Circulation Space (stairs, hallway, etc.)			280
<b>Total for 2nd Floor</b>			<b>1000</b>

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**Third Floor**

1 Audio-Visual Room (100 pax capacity)	1	160	160
2 DIGRI Room	1	40	40
3 Control Room	1	40	40
4 Classrooms (30 pax capacity)	4	40	160
5 Classrooms (60 pax capacity)	2	80	160
6 Storage Room	1	40	40
7 Lobby for AV Room	1	40	40
8 Comfort Room	1	40	40
9 Electrical Room and Utility	1	40	40
10 Circulation Space (stairs, hallway, etc.)			280
<b>Total for 3rd Floor</b>			<b>1000</b>

**Total for Main Building 3000 sq.m.**

**Pilot Plant****First Floor**

1 Mineral Processing Laboratory	1	230	230
2 Extractive Metallurgy Laboratory	1	90	90
3 Adaptive Metallurgy Laboratory	1	40	40
4 Ceramics Laboratory	1	40	40
5 Composites Laboratory	1	40	40
6 Comfort Room	1	30	30
7 Electrical Room	1	10	10
8 Circulation Space (stairs, hallway, etc.)			120
<b>Total for 1st Floor</b>			<b>600</b>

**Second Floor**

1 Dark Room Facility	1	40	40
2 Discussion Room (30 pax capacity)	1	40	40
3 Surface Science Laboratory	1	40	40
4 Comfort Room	1	30	30
5 Electrical Room	1	10	10
6 Circulation Space (stairs, hallway, etc.)			120
<b>Total for 2nd Floor</b>			<b>280*</b>

\*Mineral Processing & Extractive Metallurgy Laboratories from first floor have double-height ceiling.

**Third Floor**

1 MSMRL-Datamine Facility	1	80	80
2 Classrooms (30 pax capacity)	2	40	120
3 Classrooms (60 pax capacity)	1	80	80
4 Computational Room	1	40	40
5 Exhibition Area	1	80	80
6 Student Lounge	1	40	40
7 Comfort Room	1	30	30
8 Electrical Room	1	10	10
9 Circulation Space (stairs, hallway, etc.)			120
<b>Total for 3rd Floor</b>			<b>600</b>



Total for Pilot Plant 1480 sq.m.

## ANNEX A

### SCHEDULE OF CLASSES

COURSE PROGRAM	NO. OF COURSES PER SEM		SCHED/ TIME OF DAYS USED	PROJECTED NO. OF STUDENTS PER SECTION	PROJECTED NO. OF SECTIONS	TYPE OF CLASS ROOM		OTHER NEEDS/ EQUIPMENT	NO. OF ROOMS REQUIRED
	1st Sem	2nd Sem				1st sem	2nd sem		
Materials Engineering	12	11	8 sections am/ 4 sections pm	30-35 except for thesis & lab	2 non-thesis/ 5 thesis/lab	10lec/ 2lab	7lec/ 4lab	1. Whiteboard 2. LCD projector and screen 3. computer 4. provisions for a/c 5. ceiling fans 6. sprinkler system 7. armchairs 8. teacher's desk & chair	2 big rooms and 4 small rooms
Metallurgical Engineering	10	11	4 sections am/ 2 sections pm	30-35 except for thesis & lab	1 non-thesis/ 2 thesis/lab	8lec/ 2lab	8lec/ 3lab	1. Whiteboard 2. LCD projector and screen 3. computer 4. provisions for a/c 5. ceiling fans 6. sprinkler system 7. armchairs 8. teacher's desk & chair	1 big room and 3 small rooms
Mining Engineering	6	8	2 sections am / 4 sections pm	30-35 except for thesis & lab	1 non-thesis/ 2 thesis	6lec	6lec/ 2lab	1. Whiteboard 2. LCD projector and screen 3. computer 4. provisions for a/c 5. ceiling fans 6. sprinkler system 7. armchairs 8. teacher's	1 big room and 2 small rooms



								desk & chair	
Graduate Program	3-6	3-6	2-3 per day	20-25	1 section	2-4 lec/ 1-2 lab	2-4 lec/ 1-2 lab	1. Whiteboard 2. LCD projector and screen 3. computer 4. provisions for a/c 5. ceiling fans 6. sprinkler system 7. armchairs 8. teacher's desk & chair	2 small rooms

## ANNEX B

### CLASSROOM REQUIREMENTS

TYPE OF SPACE	NO.	CAPACITY	FURNITURE & EQUIPMENT NEEDED	ADDITIONAL SPACES TO BE INCLUDED	OTHER NEEDS	REMARKS
small classroom	7	30	1. individual armchairs 2. lcd projector (fixed/ ceiling mounted?) 3. teacher's desk		1. proper lighting 2. ventilation 3. proper acoustic treatment	with provisions for ACU and utilities
large classroom	7	60	1. individual armchairs 2. lcd projector (fixed/ ceiling mounted?) 3. teacher's desk 4. microphone		1. proper lighting 2. ventilation 3. proper acoustic treatment	with provisions for ACU and utilities

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Note: Some of the classrooms at the 2nd floor should have provisions for possible conversion into laboratories.



## ANNEX C

### LABORATORY REQUIREMENTS

LABORATORY	TYPE OF LABORATORY	FURNITURE NEEDED	EQUIPMENT TO BE USED	OTHER ITEMS NEEDED	
<b>Main Building</b>					
1	Clean Room	Laboratory used in preparing semiconductor devices maintained at a certain particle count	<ol style="list-style-type: none"> <li>1. labgown cabinet</li> <li>2. clean room shoes cabinet</li> <li>3. outdoor shoe rack/locker</li> <li>4. tables</li> <li>5. bag rack</li> <li>6. computer tables</li> <li>7. cabinet for glasswares</li> <li>8. storage cabinet for materials and spare parts</li> <li>9. waste chemical rack</li> <li>10. bookshelves</li> <li>11. gas cabinets with tank harnesses</li> <li>12. working tables</li> </ol>	<ol style="list-style-type: none"> <li>1. fume hood</li> <li>2. clean benches</li> <li>3. oxidation tube furnace</li> <li>4. tube furnace (for other gases)</li> <li>5. RF magnetron</li> <li>6. reactive ion etcher</li> <li>7. deionizer</li> <li>8. air shower</li> <li>9. spin coater</li> <li>10. oven</li> <li>11. mask aligner and UV exposure unit</li> <li>12. LPCVD system</li> <li>13. ion shower facility</li> <li>14. chillers</li> <li>15. ellipsometer</li> <li>16. optical microscope with TV monitor</li> <li>17. e-beam evaporator facility</li> <li>18. vacuum cabinet</li> <li>19. air conditioning units</li> <li>20. Czochralski crystal puller with vacuum</li> </ol>	<ol style="list-style-type: none"> <li>1. yellow room for photolithography</li> <li>2. sink with faucet</li> <li>3. waste chemical storage area</li> <li>4. discussion room</li> <li>5. exhaust system for special gases</li> <li>6. air conditioned</li> <li>7. meets 1000 particles/m<sup>3</sup> requirement for clean rooms</li> <li>8. internet connection</li> <li>9. telephone system</li> <li>10. whiteboard</li> <li>11. restricted access system</li> <li>12. requires 110 and 220 voltage sockets</li> </ol>



2	Thermal Analysis Laboratory	Materials characterizations—thermal stability, oxidative stability and thermal history of the material based on studies related to weight loss, heat evolved and dimensional changes.	1. tables for the thermal analyzers, PC, and sample preparation instruments (crimper, analytical balance, etc.) 2. chairs for operators and students 3. bookshelves for manuals 4. cabinet for storage of aluminum pans, standards, and samples 5. gas tank cabinet with tank harnesses	1. Differential Scanning Calorimeter 2. Differential Thermogravimetric Analyzer - Thermogravimetric Analyzer 3. Thermomechanical Analyzer 4. Bomb Calorimeter 5. Analytical Balance 6. air conditioning units	1. Gas tank cabinet with harness 2. crimpers 3. computer with CD writer 4. printer 5. liquid N <sub>2</sub> area 6. fire extinguishers 7. discussion room 8. internet connection 9. telephone system 10. whiteboard 11. restricted access system
3	Electron Microscopy Laboratory	Sample Characterization laboratory	1. tables for sample preparation 2. chairs 10 chairs 3. lockers for supplies and sample storage	1. SEM - Leica, Hitachi, Jeol (with PC system) 2. TEM with additional PC 3. 4. Dimpler 5. Ion sputter coater 6. Vacuum Evaporators (2 units) 7. Grinder 8. Ultrasonic cutter 9. chillers (3 units) 10. UPS 11. PC 12. vacuum pumps 13. vacuum cabinet 14. air conditioning units	1. Whiteboards 2. Framed Sample SEM/TEM Pictures 3. space for chiller 4. air-conditioning units 5. exhaust for SEM pump 6. proper grounding 7. vibration damping system 8. magnetic interference filter system 9. curtain divider for SEM and TEM facilities 10. remote control electrical lighting switch 11. restricted access system 12. telephone system 13. internet system 14. sink with faucet 15. discussion room
4	X-ray Laboratory	Sample Characterization laboratory	1. working desk and chair 2. chairs for operators and students 3. bookshelves for manuals 4. cabinets for storage of sample, X-ray unit accessories, and sample preparation tools	1. XRD with computer - Philips unit 2. XRD with accessories - old unit 3. XRF 4. chillers 5. air conditioning unit	1. faucet with sink 2. desk and chairs 3. discussion room 4. restricted access system 5. internet connection 6. telephone system



5	Substrate Processing Laboratory	Laboratory works for plating and patterning process for PCB	<ol style="list-style-type: none"> <li>1. cabinets</li> <li>2. working tables and chairs</li> <li>3. drying racks</li> <li>4. shelves</li> </ol>	<ol style="list-style-type: none"> <li>1. through-hole driller &amp; router</li> <li>2. plated through-hole board production</li> <li>3. PCB cutter</li> <li>4. photopolymer dry film laminator</li> <li>5. UV exposure box</li> <li>6. vacuum oven</li> <li>7. plating bath</li> <li>8. pulse-plating set-up</li> <li>9. DC current source</li> <li>10. water bath</li> <li>11. ultrasonic cleaner</li> <li>12. air conditioning unit</li> </ol>	<ol style="list-style-type: none"> <li>1. computer with printer</li> <li>2. sink with faucet</li> <li>3. head requirement for water supplier</li> <li>4. acid/ base liquid waste disposal area</li> <li>5. floor drain in case of spills</li> <li>6. isolation of patterning system</li> <li>7. internet connection</li> <li>8. telephone system</li> <li>9. restricted access system</li> <li>10. discussion room</li> </ol>
6	Sample Preparation Laboratory	Metallorgraphic and other sample preparation laboratory	<ol style="list-style-type: none"> <li>1. whitboard</li> <li>2. working tables</li> </ol>	<ol style="list-style-type: none"> <li>1. polishin wheels set-up</li> <li>2. diamond cutters</li> <li>3. dessicator cabinet</li> <li>4. lap grinder</li> <li>5. metallographic polishers</li> <li>6. jet polisher</li> <li>7. ultrasonic cleaner</li> <li>8. mounting press</li> <li>9. hot plate</li> </ol>	<ol style="list-style-type: none"> <li>1. sink with faucet (at least 2)</li> <li>2. exhaust fans or industrial fans</li> <li>3. drain for polishers and grinders</li> <li>4. settling tanks connected to drain of polishers and grinders</li> <li>5. telephone system</li> </ol>

LABORATORY	TYPE OF LABORATORY	FURNITURE NEEDED	EQUIPMENT TO BE USED	OTHER ITEMS NEEDED
<b>Pilot Plant Annex</b>				



1	Mineral Processing Laboratory	The mineral Processing laboratory at the pilot plant facility plays host to experimentation conducted in line with mineral processing. It houses a comminution circuit, gravity concentration equipment, chemical leach tanks, and other concentration and recovery processes. Fire assay of gold and other precious metals are also done at the pilot plant. The facility is also capable of handling bench and pilot scale mineral beneficiation for industrial demands.	<ol style="list-style-type: none"> <li>1. steel tables (2 pcs)</li> <li>2. working tables (2 pcs)</li> <li>3. monobloc stool (6 pcs)</li> <li>4. fixed white board (1)</li> <li>5. moveable white board (1 pc)</li> <li>6. sample cabinets (2 pcs)</li> <li>7. lockers (2 pcs)</li> <li>8. bag rack (1 pc)</li> <li>9. light equipment/tools cabinet (2)</li> </ol>	<ol style="list-style-type: none"> <li>1. jaw crusher (1)</li> <li>2. disc pulverizer (3)</li> <li>3. single-toggle jaw crusher (2)</li> <li>4. cone crusher</li> <li>5. gyratory crusher</li> <li>6. ball mill</li> <li>7. tube mill</li> <li>8. rod mill</li> <li>9. roll crusher</li> <li>10. vibrating screen</li> <li>11. ro-tap shaker</li> <li>12. thickeners (3)</li> <li>13. multi-launders Denver flotation cell</li> <li>14. denver flotation cell</li> <li>15. jameson cell</li> <li>16. air compressor</li> <li>17. Jig (2)</li> <li>18. Humphrey's spiral</li> <li>19. spiral classifier</li> <li>20. heavy-media separator (2)</li> <li>21. hydrocyclone</li> <li>22. magnetic separator</li> <li>23. wilfley shaking table</li> <li>24. bottle roller</li> <li>25. pelletizer</li> <li>26. jones riffle (2)</li> <li>27. brunton sampler</li> <li>28. vacuum filter</li> <li>29. water tanks (3)</li> <li>30. oil-fired muffle furnace</li> <li>31. fume hood (2)</li> <li>32. electric muffle furnace</li> <li>33. generator set</li> <li>34. water pumps (2)</li> <li>35. platform balance</li> <li>36. bowl classifier</li> <li>37. electric arc furnace</li> </ol>	<ol style="list-style-type: none"> <li>1. ventilators</li> <li>2. dust collector</li> <li>3. drainage</li> <li>4. tiled concrete tables with sink and faucet</li> <li>5. at least 8-meter headroom</li> <li>6. fluorescent lighting</li> <li>7. 10-m stack</li> <li>8. back-door garage entrance</li> <li>9. ore receiving area</li> <li>10. clean area (fire assay)</li> <li>11. sampling floor, i.e. 2.5m x 2.5m</li> <li>12. locker and shower room (at least 3 cubicles)</li> <li>13. machine shop area</li> <li>14. telephone system</li> <li>15. internet connection</li> </ol>
2	Extractive Metallurgy Laboratory	wet laboratory	<ol style="list-style-type: none"> <li>1. tiled working tables</li> <li>2. chairs</li> <li>3. lockers</li> <li>4. whiteboard</li> </ol>	<ol style="list-style-type: none"> <li>1. autoclave</li> <li>2. high temperature furnace</li> <li>3. drying oven</li> <li>4. fume hood</li> <li>5. tube furnace</li> <li>6. furnace controller</li> <li>7. DC power supply for electrolysis</li> <li>8. dessicators</li> <li>9. agitated large CIP/CIL tanks (2)</li> <li>10. agitated small CIP/CIL tanks (3)</li> <li>11. solvent extraction assembly</li> <li>12. stirring apparatus</li> <li>13. analytical balance</li> <li>14. top-loading balance</li> <li>15. water distiller</li> <li>16. pH meter-electrode type</li> <li>17. ultrasonic cleaner</li> <li>18. optical pyrometer with tripod</li> <li>19. water bath</li> <li>20. potentiostat</li> <li>21. Atomic Absorption</li> </ol>	<ol style="list-style-type: none"> <li>1. ceramic sink with faucet (2)</li> <li>2. glassware/sieve storage room</li> <li>3. discussion room</li> <li>4. gowning area</li> <li>5. ventilation system</li> <li>6. waste storage facilities</li> <li>7. gas cabinet with tank harnesses</li> </ol>



				Spectrometer	
3	Ceramics Laboratory	The proposed laboratory is designed for conducting research and development on processing and characterization of advanced ceramic and ceramic-composite materials such as structural and functional ceramics. The laboratory will be divided into three major research areas, namely, powder preparation/processing (including production of nanopowders and novel processing techniques), characterization, and sintering / heat treatment.	1. laboratory tables and chairs 2. cabinets	1. planetary ball mill 2. vacuum oven 3. dessicators	1. water system with laboratory sink and eye wash facilities 2. fume hood and ventilating system 3. the processing room (polishing, ball milling) should be constructed in such a way to minimize noise 4. discussion room 5. researcher's working station, i.e. desk and chair 6. internet connection 7. telephone system 8. whiteboard
4	Adaptive Metallurgy Laboratory			1. Heat treatment furnace 2. swaging machine 3. spin casting 4. foundry facilities 5. jominy apparatus 6. welding facility 7. lathe	1. telephone system 2. internet connection 3. discussion room 4. whiteboard





5	Composites Laboratory	Sample synthesis and testing laboratory of advanced composite materials	1. laboratory tables and chairs for sample preparation 2. working stations (with computer) 3. concrete tables as mount for table-top testing machines	1. weighing scales 2. mixers 3. fume hood 4. sink with faucet 5. vacuum oven 6. table-top universal testing machine 7. floor-mounted universal testing machine 8. Brinell hardness tester 9. Rockwell hardness tester 10. Vickers microhardness tester 11. press and die 12. vacuum pump 13. mic-d microscope with computer 14. impact tester 15. fatigue test 16. thermal conductivity meter 17. data acquisition system with computer 18. air conditioning unit	1. air-conditioning unit 2. discussion room 3. "extendable faucet" 4. researcher's area 5. whiteboard 7. internet connection 8. telephone system 9. grounding system 10. vibration damping system 11. restricted access system 12. researchers' room 13. ventilation system
6	Optical Microscopy Laboratory	lab for optical characterization of samples	1. chairs (9 pcs) 2. sturdy table/benches 3. tables with electrical 10 sockets	1. SMA 2. 2-3 metallurgical microscopes 3. mic-d microscopes with computer 4. inverted microscopes 5. binocular microscopes 6. high luminance lamps	1. good lighting is of prime importance 2. air-conditioning unit 3. cabinets 4. telephone system 5. discussion room 6. whiteboard
7	MSMRL-Datamine Facility	computing laboratory	1. cabinet 2. working tables and chairs	1. computers (15) 2. mine plotter 3. digitizer 4. drafting table 5. airconditioning unit 6. projector	1. whiteboard 2. lcd projector screen 3. telephone system 4. internet connection 5. fire extinguisher 6. restricted access system
8	Surface Science Laboratory			1. air conditioning unit	1. telephone system 2. internet connection 3. discussion room 4. whiteboard 5. researchers room
9	Dark Room Facility	positive and negative development of films	1. stool (2) 2. sink with faucet 3. chemical basins	1. airconditioning unit 2. developing set-up 3. enlarger 4. drying facility 5. refrigerator 6. film/ paper cutter 7. (please ask Brian other items used in Met E 148 experiment)	1. windows painted opaque black 2. yellow/red light 3. chemical waste storage 4. double door system for light exposure protection



## ANNEX D

### SUPPORT SPACES REQUIREMENTS

TYPE OF SPACE	CAPACITY	FURNITURE NEEDED	ADDITIONAL SPACES TO BE INCLUDED	OTHER NEEDS	REMARKS
department chair's office	10	1. executive desk and chair 2. computer table 3. conference table and chairs for 8 4. bookshelves 5. filing cabinets 6. consultation table 7. secretary's table and chair 8. visitor's chair (2) 9. personal refrigerator	toilet with shower stall	1. telephone system 2. intercom 3. airconditioning system 4. internet connection	1. conference area is for small consultation groups or meetings of the chair 2. maximum capacity considers 8 visitors and a secretary other than the chairman.
administration office	5	1. office tables and chairs 2. filing cabinets 3. bookshelves 4. supplies cabinet 5. pantry (near chairman's office) 6. computer tables and chairs 7. fax machine 8. printers 9. copier	1. visitors area 2. reception area for students	1. telephone system 2. intercom 3. airconditioning system	1. capacity includes the admin officer, 2 admin assistants and 2 student assistants.
faculty offices	10/room	1. executive chairs 2. small consultation table (for 2) and chairs 3. bulletin board 4. magazine rack 5. book shelves 6. filing cabinets		1. telephone system 2. intercom 3. airconditioning system 4. water dispensers 5. internet 6. emergency lamps 7. ceiling fan	1. five faculty will occupy a room but provision for one student in consultation with the faculty
conference room	25	1. conference table 2. side tables with bottom shelves		1. lcd projector 2. coffee maker	1. sound proof 2. proper lighting 3. airconditioned
student lounges	30	1. large table and chairs 2. bulletin board 3. lockers	1. locker area		1. each floor can house a space for student lounges near the stairs 2. no special room needed 3. locker can be rented out
audio-visual room	100	1. chairs 2. podium 3. stage 4. white screen 5. projector	1. alleys or pathways at two sides and in the middle	1. proper lighting system 2. speaker system 3. projector system 4. air conditioning unit	



exhibition hall/museum	100	1. poster boards 2. tables 3. display cabinets		1. lighting system	
control room/ technician's office	4	1. desks and chairs 2. filing cabinets 3. computer tables 4. printer 5. lockers			
faculty lounge	50	1. sofa 2. lounging chairs 3. bar 4. buffet table 5. buffet cabinet		1. coffee maker 2. microwave oven 3. refrigerator 4. lcd tv 5. dvd player	1. sound-proofing 2. accessible to faculty room
reagent & glassware stock room	1	1. storage cabinets and shelves 2. explosion proof cabinet		1. fire extinguishers	ventilation and lighting system, step ladder
gas storage room				1. gas leak detector	tank chains, tank stands, gas trolley
generator set house					well ventilated area



## ANNEX F

### EXISTING EQUIPMENT/FURNITURE

(Laboratories are arranged in alphabetical order.)

EQUIPMENT/ FURNITURE	EXISTING LOCATION	FUTURE LOCATION	QUANTITY & DIMENSION	SPECIAL REQUIREMENT
<b>Adaptive Laboratory</b>				
1 Swage Machine	NEC Basement	1/F Pilot Plant	1 unit, 1.36 m x 1.16 m	1. Voltage reqt: 220V 2. 60 A
2 Lathe Machine	NEC Basement	1/F Pilot Plant	1 unit, 2.57 m x 1.4 m	1. Voltage reqt: 220V 2. power rating: 60 A
3 Welding Machine	NEC Basement	1/F Pilot Plant	1 unit, 1.57 m x 1.32 m	1. Voltage reqt: 220V 2. power rating: 60 A
4 Drill Press	NEC Basement	1/F Pilot Plant	1 unit, 0.3 m x 0.3 m	1. Voltage reqt: 220V 2. power rating: 30 A
<b>Ceramics Laboratory</b>				
1 Planetary ball mill	NEC 215	2/F Pilot Plant Annex	1 unit/ 0.5 m x 0.3m x 0.4 m	220 V; nearby outlet; concrete table
2 Tables and chairs	NEC 215	2/F Pilot Plant Annex	standard size	
<b>Clean Room</b>				
1 Fume Hood	Shono Laboratory NEC 116	Clean Room	2m x 1m x 3.5m (2 pcs.)	1. Ventilation 2. Voltage Req: 220V 3. Power rating: 1120 W (motor) 4. next to the wall connected to the exhaust system that goes up to the roof
2 Clean Bench	Shono Laboratory NEC 116	Clean Room	2m x 1m x 3m (2 pcs.)	1. Ventilation 2. Voltage Req: 220V 3. Rating: 6600W 4. next to the wall
3 Oxidation Tube Furnace plus power supply	Shono Laboratory NEC 116	Clean Room	1m x 1m x 0.25m	1. Ventilation 2. Voltage Req: 100V 3. Rating: 3300W 4. Tank cage  POWER SUPPLY: 5. Voltage Req: 100V 6. Rating: 9A
4 Tube Furnace (For other LPCVD)	Shono Laboratory NEC 116	Clean Room	1m x 1m x 0.25m	1. Ventilation 2. Voltage Req: 100V 3. Rating: 3300W 4. Gas Tank cage 5. connected to exhaust system that goes up to the roof
5 Digital Hot Plate/Stirrer (Cole Palmer 04644)	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 250V 2. Rating: 3. will be placed inside fume hood
6 RF Magnetron Sputtering Facility plus Computer Interface	Shono Laboratory NEC 116	Clean Room	2m x 1m x 1.5m	1. Voltage reqt: 220V 2. Voltage Regulator 3. Rating: 8800W
7 Reactive Ion Etcher Facility plus Computer Interface	Shono Laboratory NEC 116	Clean Room	1m x 1m x 2m	1. Voltage Req: 220 V 2. Rating: 30A 3. Gas Tank cage



					4. connected to exhaust system
8	Deionizer	Shono Laboratory NEC 116	Clean Room	1m x 0.5m x 1.5m	1. voltage reqt: 2. power rating: 3.connects to the water piping system
9	Ion Shower Facility	Shono Laboratory NEC 116	Clean Room	1.5m x 1m x 1.5m	1. Voltage Req: 100V 2. Power rating: 8000W 3. Gas Tank cage 4. requires 1.5m perimeter clearance to the next equipment
10	Air Shower	Shono Laboratory NEC 116	Clean Room	2m x 1.5m x 3m	1. Voltage reqt: 2. power rating: 3. next to the main entrance and requires 1.5m clearance on both sides for the swinging doors
11	Spin Coater & Pump	Shono Laboratory NEC 116	Clean Room	2 units/ 0.25m x 0.25m x 0.25m	1. Voltage reqt: 100V 2. inside fumehood 3. power rating: 1100 watts  PUMP 1. Voltage Req: 100V 2. Rating: 3.6A (Motor)
12	Oven	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 220 V 2. power rating:1100 watts
13	Tables	Shono Laboratory NEC 116	Clean Room	2 units/ 1m x 0.5m x 1m	
14	Computer Table	Shono Laboratory NEC 116	Clean Room	1m x 0.5m x 1.5m	
15	Ultrasonic cleaner	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 220 V 2. power rating:880 watts
16	Barnstead & Thermolyne Analog Hotplate	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 220V 2. power rating: 345W
17	Ellipsometer & Microscope	Shono Laboratory NEC 116	Clean Room	0.5m x 0.5m x 1m	1. Voltage Req: 220V 2. Voltage Regulator: 20A 3. Gas Tank cage 4. power rating: 4400 watts  MICROSCOPE 1. Voltage Req: 100V
18	Vacuum Evaporator	Shono Laboratory NEC 116	Clean Room	0.5m x 0.5m x 1m	1. Voltage Req: 100V 2. Rating: 2200 watts (Main breaker) 3. Ventilation
19	Air-Conditioning Units (Window Type)	Shono Laboratory NEC 116	Clean Room	1m x 0.5m x 0.5m (2 pcs.)	1. Voltage Req: 220V 2. Power Rating: 22680 W
20	Camera Control Unit	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage Req: 100V 2. Power Rating: 14W
21	Rotary Pump	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage Req: 100V 2. Power Rating: 400W
22	Rotary Pump	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage Req: 100V 2. Rating: 946 W
23	Vacuum Pump	Shono Laboratory NEC 116	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage Req: 100V 2. Power Rating: 14W



24	Humidifier	Shono Laboratory NEC 116	Clean Room		1. Voltage Reqt: 110V 2. Rating: 550W
25	LPCVD System module with Plasma Etchers	Shono Laboratory NEC 116	Clean Room	3m x 1.5m x 3m	1. with 220 and 110V sockets
<b>Composites Laboratory</b>					
1	Shear Mixer	NEC 214	2/F Pilot Plant Annex	1m x 0.5m x 0.5m	1. voltage reqt: 220 volts 2. power rating: 3. exhaust fan 4. mounted on concrete table
2	Oven with vacuum pump	NEC basement	2/F Pilot Plant Annex	0.5m x 0.75 m x 1m	1. voltage reqt: 220 volts 2. power rating: 3. two nearby sockets
3	Dessicator with vacuum pump	NEC 214	2/F Pilot Plant Annex	2 units/ 0.5m x 0.5m x 0.5m each	1. voltage reqt: 220 volts 2. power rating: 3. four nearby sockets 4. exhausts 5. mounted on concrete table
4	Fume hood	NEC Extractive laboratory	2/F Pilot Plant Annex	2m x 1m x 0.75m	1. voltage reqt: 220 volts 2. power rating: 3. water drain 4. exhaust connected to hood
5	Table-top Universal Testing Machine with computer and data acquisition system attachment	NEC 214	2/F Pilot Plant Annex	1m x 0.5m x 2m	1. voltage reqt: 220 volts 2. power rating: 3. space to work around 4. cabinet for fixture and load cell storage 5. computer table 6. grounding connection 7. vibration damping system 8. mounted on concrete table
6	Thermal Conductivity Apparatus with computer and data acquisition system attachment	NEC 214	2/F Pilot Plant Annex	0.75m x 0.5 m x 1m	1. voltage reqt: 220 volts 2. power rating: 3. four nearby sockets 4. computer table with additional space for data logger 5. cabinet for storage of parts
7	Analytical balance	NEC 214	2/F Pilot Plant Annex	0.5m x 0.5m x 0.5m	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. vibration damping system 5. mounted on table
8	Hardness testers	Joeres laboratory, 1/F NEC	2/F Pilot Plant Annex	2 units/ 0.5m x 0.5m x 1.5m each	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. vibration damping system 5. storage cabinets for tools and spare parts 6. mounted on table
9	Micro-Hardness testers	Joeres laboratory, 1/F NEC	2/F Pilot Plant Annex	0.5 m x 0.5m x 0.5m	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. vibration damping system 5. storage cabinets for tools and spare parts 6. mounted on table
10	Press and Die		2/F Pilot Plant Annex	0.75 m x 0.5m x 1m	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. vibration damping system 5. storage cabinets for tools and spare parts



11	Mic-d Microscope with computer	MH 113	2/F Pilot Plant Annex	0.5 m x 1m x 0.5m	1. voltage reqt: 220 volts 2. power rating: 3. mounted on flat table
12	Impact Tester	Extractive Laboratory, 1/F NEC	2/F Pilot Plant Annex	0.5 m x 0.5m x 1m	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. storage cabinet for tools and spare parts
13	Fatigue Tester	Extractive Laboratory, 1/F NEC	2/F Pilot Plant Annex	1 unit/ 1 m x 1 m	1. voltage reqt: 220 volts 2. power rating: 3. flat and sturdy table 4. storage cabinet for tools and spare parts
14	Split-type Air-conditioning Unit	NEC 214	2/F Pilot Plant Annex	1 m x 0.5 m x 2m	1. voltage reqt: 220 volts 2. power rating: 2 hp 3. drain 4. connection to external set-up
15	Long table for hardness testers	1/F NEC, Joeres Laboratory	2/F Pilot Plant Annex	4m x 1m x 1m	1. near wall with sockets
<b>Electron Microscopy Laboratory</b>					
1	Ion sputtering Apparatus	NEC 214	1/F Main Building	1 unit/ 1m x 0.5m	
2	Vacuum Evaporator	NEC 214 and Electron Microscopy Laboratory, 1/F NEC	1/F Main Building	2 units/ 1 m x 0.5m	
3	SEM pump	NEC 214	1/F Main Building	1 unit/ 0.25 m x 0.25 m	
4	Jeol SEM	NEC 214	1/F Main Building	1 unit/ 1.25m x 0.75 m	
5	Chiller	NEC 214	1/F Main Building	1 unit/	
<b>Extractive Metallurgy Laboratory</b>					
1	Autoclave	1/F NEC	1/F Pilot Plant Annex	0.75m x 0.5m x 1m	220 V 0.25 HP
2	Muffle furnace	1/F NEC	1/F Pilot Plant Annex	0.75m x 0.75m x 0.5m	220 V 2.7 kW
3	Oven	1/F NEC	1/F Pilot Plant Annex	1m x 1m x 0.75m	220 V 5 Amps
4	Fume Hood	1/F NEC	1/F Pilot Plant Annex	1m x 1.5m x 2.5m	220 V 1.5 HP motor (40 watts light)
5	tube furnace	1/F NEC	1/F Pilot Plant Annex	1.5m x 1m	220 V (110 V per motor) 1.2 kW
6	furnace controller	1/F NEC	1/F Pilot Plant Annex	0.75m x 0.75m x 0.5m	220 V 22 Amps
7	DC power supply	1/F NEC	1/F Pilot Plant Annex	0.5m x 1m x 0.5m	
8	Locker	1/F NEC	1/F Pilot Plant Annex	0.25m x 0.05m	
9	working table	1/F NEC	1/F Pilot Plant Annex	0.25m x 0.08m	
10	exhaust fan	1/F NEC	1/F Pilot Plant Annex	0.07m x 0.07m	220 V
<b>Mineral Processing Laboratory</b>					
1	Single Toggle Jaw Crusher	Pilot Plant	1/F Pilot Plant Annex	3 units/ 1.5 x 1m x 1m	1. Voltage reqt: 230 V 2. power rating: 2237 W 3. 3-phase motor 4. Raised on 1-m platform
2	Cone Crusher	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 0.7m	1. Voltage reqt: 230 V 2. power rating: 2250 W



					3. Raised on 1-m platform
3	Roll Crusher	Pilot Plant	1/F Pilot Plant Annex	2m x 1.5m x 0.7m	1. Voltage reqt: 230 V 2. power rating: 2737 W 3. Raised on 1-m platform
4	Tube Mill	Pilot Plant	1/F Pilot Plant Annex	2.5m x 1.5m x 1.5m	1. Voltage reqt: 220V 2. power rating: 372 W 3. Raised on 1.5-m scaffold
5	Ball Mill	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1m	1. Voltage reqt: 220V 2. power rating: 186W
6	Rod Mill	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1m	1. Voltage reqt: 220 V 2. power rating: 186W
7	Vibrating Screen	Pilot Plant	1/F Pilot Plant Annex	1.5m x 1m x 1.7m	1. Voltage reqt: 220V 2. power rating: 1870W 3. Raised on 1-m platform
8	Disc Pulverizers	Pilot Plant	1/F Pilot Plant Annex	3 units/ 1.5m x 1.5m x 0.6m	1. Voltage reqt: 220V 2. power rating: 2860W 3. 3-phase motor 4. Raised on 1-m platform
9	Ro-tap Sieve Shaker	Pilot Plant	1/F Pilot Plant Annex	2 units/ 0.7m x 0.7m x 1.6m	1. Voltage reqt: 220V 2. power rating: 2860W
10	Thickener	Pilot Plant	1/F Pilot Plant Annex	3 units/ 2m x 2m x 1m	1. Voltage reqt: 220V 2. power rating: 746W 3. Mounted on 1-m legs
11	Large Agitated CIP/CIL Tanks	Pilot Plant	1/F Pilot Plant Annex	2 units/ 1.5m x 1.5m x 2m	1. Voltage reqt: 220V 2. power rating: 186W 3. Mounted on 2-m legs
12	Small Agitated CIP/CIL Tanks	Pilot Plant	1/F Pilot Plant Annex	3 units/ 2.5m x 1.5m x 1m	1. Voltage reqt: 220V 2. power rating: 186W 3. Mounted on table
13	Multi- launder Denver Flotation Cell	Pilot Plant	1/F Pilot Plant Annex	2.5m x 1m x 2m	1. Voltage reqt: 220V 2. power rating: 186W x 4 3. Water supply
14	Denver Flotation Cell	Surface Science Lab, 1/F NEC	1/F Pilot Plant Annex	0.7m x 0.7m x 1m	1. Voltage reqt: 220V 2. power rating: 186W
15	Jameson Flotation Cell	Pilot Plant	1/F Pilot Plant Annex	1.5m x 1.5m x 4m	1. Voltage reqt: 220V 2. power rating: 186 W 3. Headroom: 6m
16	Amalgamation Mill	Pilot Plant	1/F Pilot Plant Annex	1m x 0.8m x 1m	1. Voltage reqt: 220V 2. power rating: 372W
17	Humphrey Spiral	Pilot Plant	1/F Pilot Plant Annex	2m x 1m x 3m	1. Water Supply 2. voltage reqt: 220V 3. power rating: 1118W
18	Jig	Pilot Plant	1/F Pilot Plant Annex	2 units/ 1m x 0.7m x 1m	1. Voltage reqt: 220V 2. power rating: 186 W 3. Water Supply
19	Spiral Classifier (1)	Pilot Plant	1/F Pilot Plant Annex	2.5m x 0.7m x 1.5m	1. Voltage reqt: 220V 2. power rating: 745W 3. Mounted on 1-m legs
20	Heavy Media Separator (1)	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1m	1. Voltage reqt: 220V 2. power rating: 186W 3. Mounted on 1-m legs
21	Bowl Classifier (1)	Pilot Plant	1/F Pilot Plant Annex	1.5m x 1.5m x 1m	1. Voltage reqt: 220V 2. power rating: 186W 3. Water Supply
22	Hydrocyclone (1)	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1m	
23	Cross-belt Magnetic Separator (1)	Pilot Plant	1/F Pilot Plant Annex	3m x 1.5m x 1.5m	1. Voltage reqt: 220W 2. power rating: 352W x 3 3. Rectifier
24	Wilfley Shaking Table (1)	Pilot Plant	1/F Pilot Plant Annex	2m x 1m x 0.7m	1. Voltage reqt: 220V 2. power rating: 186W 3. Water Supply
25	Bottle Roller (1)	Pilot Plant	1/F Pilot Plant Annex	2.5m x 1.5m x 1m	1. Voltage reqt: 220V 2. power rating: 770W





26	Pelletizer (1)	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1m	1. Voltage reqt: 220V 2. power rating: 186W
27	Vacuum Filter (1)	Pilot Plant	1/F Pilot Plant Annex	2m x 1m x 0.5m	1. Voltage reqt: 220V 2. power rating: 372.85W 3. Near drainage
28	Air Compressor (1)	Pilot Plant	1/F Pilot Plant Annex	1.5m x 0.7m x 1m	1. Voltage reqt: 220V 2. power rating: 2750W
29	Generator Set (1)	Pilot Plant	1/F Pilot Plant Annex	2.5m x 1.5m x 2m	1. Voltage reqt: 2. power rating:
30	Water Pump (2)	Pilot Plant	1/F Pilot Plant Annex	2 units/ 0.5m x 0.5m x 0.5m	1. Voltage reqt: 220V 2. power rating: 372.85W
31	Jones Riffle Splitter (2)	Pilot Plant	1/F Pilot Plant Annex	2 units/ 0.5m x 0.5m x 0.5m	
32	Water Tanks (3)	Pilot Plant	1/F Pilot Plant Annex	3 units/ 1m x 1m x 2m	1. Mounted on 3-m legs
33	Electric Muffle furnace (1)	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1.5m	1. Voltage reqt: 220V 2. power rating: 2706W
34	Gas-fired Muffle Furnace (1)	Pilot Plant	1/F Pilot Plant Annex	1m x 1m x 1.5m	1. Near fume hood
35	Fume Hood (1)	Pilot Plant	1/F Pilot Plant Annex	2m x 1.5m x 1.5m	1. Voltage reqt: 220V 2. power rating: 8800W 3. Wall mounted below stack
36	Electric Arc Furnace (1)	Metallurgical Lab, Basement NEC	1/F Pilot Plant Annex	1.5m x 1.5m x 2m	1. Voltage reqt: 2. power rating:
37	Platform Balance (1)	Pilot Plant	1/F Pilot Plant Annex	1.5m x 1m x 1.5m	
38	Air Cyclone Classifier (1)	Pilot Plant	1/F Pilot Plant Annex	1.5m x 0.5m x 2m	1. Voltage reqt: 220V 2. power rating: 186W
<b>MSMRL-Datamine Facility</b>					
1	Desktop Computers	NEC 407	3/F Pilot Plant Annex	3 units/ 1.2m x 1.2m x 2m	1. Voltage reqt: 220 V 2. power rating: 1000 W 3. mounted on table
2	tablet digitizer	NEC 407	3/F Pilot Plant Annex	1.5m x 1m x 2m	1. Voltage reqt: 220 V 2. power ratings: 1000 W
3	plotter	NEC 407	3/F Pilot Plant Annex	2m x 1.5m x 1.5m	1. Voltage reqt: 220 V 2. power rating: 1000 W
4	working table	NEC 407	3/F Pilot Plant Annex	1.5m x 2.5m x 1m	
5	air-conditioning unit	NEC 407	3/F Pilot Plant Annex	2 units	1. Voltage reqt: 220V 2. power rating: 2608W
<b>Optical Microscopy Laboratory</b>					
1	Metallurgical Microscope	Joeres laboratory, 1/F NEC	3/F Main Bldg	1 unit, 0.3 m x 0.7 m x 1.2 m	1. Voltage reqt: 220 V 2. power ratings: 150 W
2	Surface Morphology Apparatus	Joeres laboratory, 1/F NEC	3/F Main Bldg	1 unit, 0.3 m x 0.7 m x 1.2 m	1. Voltage reqt: 220 V 2. power ratings: 400 W
3	Inverted Microscope	Joeres laboratory, 1/F NEC	3/F Main Bldg	1 unit, 0.3 m x 0.7 m x 1.2 m	1. Voltage reqt: 220 V 2. power ratings: 400 W
4	Working table	Joeres laboratory, 1/F NEC	3/F Main Bldg	1 unit, 1.6m x 0.8m x 0.6 m	
5	Cabinet	Joeres laboratory, 1/F NEC	3/F Main Bldg	1 unit, 1.2 m x 0.5 m x 1.85 m	
<b>Sample Preparation Laboratory</b>					
1	Polisher			1 unit/ 0.75m x 0.75m	
2	Polishing Table			1 unit/ 1.5 m x	



				0.75m	
<b>Substrate Processing Laboratory</b>					
1	through hole drill & router	NEC Basement	1/F Main Building	2m x 4m x 0.25m	1. Motor: 350 W 2. Drill: 660 W 3. mounted on table 4. voltage reqt: 220V
2	plated through hole board	NEC Basement	1/F Main Building	2 units/ 1.5m x 2m each	1. Voltage reqt: 220V 2. power rating: 2000 W 2520 W 3. headroom requirement for water pump system (220 V, 506W)
3	PCB Cutter	NEC Basement	1/F Main Building	1m x 2m	1. mounted on table
4	photopolymer dry film laminator & UV exposure box	NEC Basement	1/F Main Building	2m x 4m	1. Voltage reqt: 220V 2. power rating: 484 W for laminator 5.7 A for exposure box
5	vacuum furnace	NEC Basement	1/F Main Building	1m x 1m	1. Voltage reqt: 220 V 2. power rating: 6600W 3. mounted on table
6	plating bath (with stirrer)	NEC Basement	1/F Main Building	0.25m x 0.5m	1. Voltage reqt: 220 V 2. power ratings: 1540W
7	pulse plating set-up	NEC Basement	1/F Main Building	1m x 2m	1. Voltage reqt: 115/230 V 2. Current: 4400W 3. mounted on table
8	white board	NEC Basement	1/F Main Building	2m x 4m	
9	air conditioning unit	NEC Basement	1/F Main Building		1. Voltage reqt: 220 V 2. power rating: 1865 W
10	computer	NEC Basement	1/F Main Building		monitor: 100W AVR: 1100W
11	fume hood	NEC Basement	1/F Main Building		1. Voltage reqt: 220V 2. power rating: 1119W (motor) 3. connected to exhaust system
12	sink with faucet	NEC Basement	1/F Main Building		
<b>Thermal Analysis Laboratory</b>					
1	Long table for TA apparatus, PC, and sample preparation instruments	1/F NEC, Joeres Laboratory	1/F Main Building		1. with lockers for storage of tools and spare parts
2	Chairs for operators and students	1/F NEC, Joeres Laboratory	1/F Main Building		
3	Bookshelves for manuals	1/F NEC, Joeres Laboratory	1/F Main Building	3m x 1m x 3m	
4	Cabinets for storage of aluminum pans, standards, and sampels	1/F NEC, Joeres Laboratory	1/F Main Building	3m x 1m x 3m	
5	DSC	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1.5m	1. Voltage reqt: 110 V 2. power rating: 2000 W
6	DTA-TGA (SDT)	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1.5m	1. Voltage reqt: 110 V 2. power rating:2000 W
7	TMA	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1.5m	1. Voltage reqt: 110 V 2. power rating:2000 W
8	System controller-PC	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1.5m	1. Voltage reqt: 110 V 2. power rating:300 W
9	Analytical Balance	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1.5m	1. Voltage reqt: 220 V 2. power rating:100 W
<b>X-ray Laboratory</b>					
1	XRD instrument with computer	1/F NEC, Joeres Laboratory	1/F Main Building	1.5m x 1.5m x 2m	1. Voltage reqt: 220 V 2. power rating:5000 W



2	XRF instrument with computer	NEC 214	1/F Main Building	1.5m x 1.5m x 0.5m	1. Voltage reqt: 230 V 2. power rating: 5000 W
3	Old XRD unit with accessories	NEC 214	1/F Main Building	2m x 1.5m x 1m	1. Voltage reqt: 230 V 2. power rating: 5000 W
4	Chiller	1/F NEC, Joeres Laboratory	1/F Main Building	0.5m x 0.5m x 1m	1. Voltage reqt: 220 V 2. power rating: 4400 W



## ANNEX G

### NEW EQUIPMENT & FURNITURE (TO BE PROCURED)

(Laboratories are arranged in alphabetical order.)

EQUIPMENT/FURNITURE	PROPOSED LOCATION	QUANTITY & DIMENSION	SPECIAL REQUIREMENTS
<b>Adaptive Laboratory</b>			
1 High temperature Furnace (up to 2000 C)	2/F Pilot Plant Annex	1 unit 1.4 m x 1.4 m	220 V, nearby socket
2 spin casting	2/F Pilot Plant Annex	1 unit 1.2 m x 1.4 m	220 V, nearby socket
3 Foundry Bin (setup for making sand molds)	2/F Pilot Plant Annex	1 unit 1.6 m x 2.4 m	
4 Lockers	2/F Pilot Plant Annex	1 unit 1.5 m x 0.63 m	
5 Discussion Table	2/F Pilot Plant Annex	1 unit 1.5 m x 1.3 m	
<b>Ceramics Laboratory</b>			
1 Planetary ball mills	2/F Pilot Plant Annex	1 unit; 0.5m x 0.5m x 0.4m	220V; concrete table
2 Grinder/mixer; mechanized	2/F Pilot Plant Annex	1 unit; 0.4m x 0.4m x 0.4m	220V; concrete table
3 Pot mills, 0.5 kg to 3 kg cap; motor driven	2/F Pilot Plant Annex	3 units pot mills, variable capacity; 1unit motor	220V; 0.5 hp motor
4 Autoclave/hydrothermal reactor	2/F Pilot Plant Annex	1unit; 0.75m x 0.75m x 1m	220V; nearby socket; safety switch/fuse
5 Temperature controlled extruder	2/F Pilot Plant Annex	1 unit; 0.5m x 0.5m x 1.5m	220 volts; nearby sockets; concrete table
6 tape casting machine	2/F Pilot Plant Annex	1 unit; 0.5m x 0.4m x 1m	concrete table
7 hydraulic press with gage (with metal molds), 50 tonnes	2/F Pilot Plant Annex	1 unit; 0.75m x 0.75m x 1.5m	
8 high temperature furnace (up to ~1700°C, programmable)	2/F Pilot Plant Annex	1 unit; 0.6m x 1m x 0.6m	220V; nearby socket; concrete table; safety switch/fuse
9 tube furnace	2/F Pilot Plant Annex	1 unit; 0.3m x 0.7m x 0.5m	220V; nearby socket; concrete table; safety switch/fuse
10 pressureless vacuum furnace	2/F Pilot Plant Annex	1 unit; 0.6m x 1m x 0.6m	220V; nearby socket; concrete table; safety switch/fuse
11 microwave oven, high power rating	2/F Pilot Plant Annex	1 unit; 0.5m x 0.75m x 0.5m	220V; nearby socket; concrete table; safety switch/fuse
12 vacuum oven	2/F Pilot Plant Annex	1 unit; 0.5m x 0.5m x 0.6m	220V; nearby socket; concrete table; safety switch/fuse
13 hot isostatic press (30,000 psi)	2/F Pilot Plant Annex	1 unit; 0.75m x 0.75m x 1.5m	220V; nearby socket
14 mechanical (uniaxial) hot press	2/F Pilot Plant Annex	1 unit; 0.75m x 0.75m x 1.5m	220V; nearby socket
15 particle size analyzer with computer and accessories	2/F Pilot Plant Annex	1 unit; 1.5m x 1m x 1m	220V; nearby socket; concrete table
16 multi-point BET surface area analyzer	2/F Pilot Plant Annex	1 unit; 0.5m x 0.5m x 1m	concrete table
17 Piezoelectric Measurement Equipment and accessories	2/F Pilot Plant Annex	1 unit; 0.75m x 0.75m x 1m	220 V; concrete table
18 Potentiostat and accessories	2/F Pilot Plant Annex	1 unit; 0.4m x 0.4m x 0.75m	
19 Refractometer (Abbe)	2/F Pilot Plant Annex	1 unit	



20	Vacuum filter and accessories	2/F Pilot Plant Annex	1 unit, 0.25m x 0.5m	220 V; nearby socket; concrete table
21	centrifuge machine and accessories	2/F Pilot Plant Annex	1 unit, 0.4m diameter x 0.4m ht	220 V; nearby socket; concrete table
22	Analytical balance, electronic	2/F Pilot Plant Annex	1 unit, 0.5m x 0.5m x 0.5m	220 V; nearby socket; concrete table
23	Air blast with compressor	2/F Pilot Plant Annex	1 unit, 0.25m x 0.25m x 1m	
24	Ultrasonic cleaner	2/F Pilot Plant Annex	1 unit, 0.25m x 0.25m x 0.25m	220 volts; nearby socket
25	Dessicator with dessicants	2/F Pilot Plant Annex	3 units, 0.4 m diameter, 0.4m ht	concrete table
26	Fume hood	2/F Pilot Plant Annex	2m x 1 m x 3m, 1unit	
27	Fire extinguishers	2/F Pilot Plant Annex	2 units	2 types
28	Computer, printer, scanner	Ceramics lab office	1unit each	220V,nearby socket
29	Air-conditioning unit	Ceramics lab office /discussion room	1 unit	220V
30	Office/laboratory tables and chairs	2/F Pilot Plant Annex		
31	Storage cabinets and racks	2/F Pilot Plant Annex		

#### Clean Room

1	Mask Aligner and UV Exposure Unit	Clean Room	1m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
2	Workstation (Desks)	Clean Room	1.5m x 1m x 1m (2 pcs)	1. Voltage reqt: 2. power rating:
3	Ellipsometer	Clean Room	0.5m x 0.5m x 0.5m	1. Voltage reqt: 2. power rating:
4	Analytical Balance	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 2. power rating:
5	Optical Microscope	Clean Room	0.25m x 0.25m x 0.25m	1. Voltage reqt: 2. power rating:
6	Lab gown cabinet or locker	Clean Room	1m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
7	Clean room shoes cabinet or locker	Clean Room	1m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
8	Outdoor shoe rack or locker	Clean Room	1m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
9	Bag racks or locker	Clean Room	1.5m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
10	Storage cabinet for supplies and spare parts	Clean Room	3m x 1m x 3m	1. Voltage reqt: 2. power rating:
11	Mask Aligner and UV Exposure Unit	Clean Room	2m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:
12	Waste chemicals rack	Clean Room	1m x 0.5m x 1m	1. Voltage reqt: 2. power rating:
13	Bookshelves	Clean Room	2m x 0.5m x 1.5m	1. Voltage reqt: 2. power rating:

#### Composites Laboratory

1	twin extruder	1/F Pilot Plant Annex	1.5m x 2m x 1.5m	1. Voltage reqt: 230V 2. power rating:
2	roll mill	1/F Pilot Plant Annex	2m x 1.5m x 1.5m	1. Voltage reqt: 230V 2. power rating:
3	injection molder	1/F Pilot Plant Annex	2m x 1.5m x 1.5m	1. Voltage reqt: 230V 2. power rating:
4	high load universal testing machine	1/F Pilot Plant Annex	1.5m x 2m x 2.5m	1. Voltage reqt: 230V 2. power rating:
5	Ultrasonic cleaner	1/F Pilot Plant Annex	0.5m x 0.5m x 0.5m	1. Voltage reqt: 230V 2. power rating:
6	hot press/compression molder	1/F Pilot Plant Annex	1.5m x 1.5m x 2.5m	1. Voltage reqt: 230V 2. power rating:



<b>Extractive Metallurgy Laboratory</b>				
1	Dessicator	1/F Pilot Plant Annex		
2	Chairs	Discussion Room		
<b>Mineral Processing Laboratory</b>				
1	Steel Tables (2)	1/F Pilot Plant Annex	2 pcs, 3m x 1.5m x 1.5m	1. Voltage reqt: 110V/230V 2. power rating: 1kW 3. 110V/230V Sockets w/ cover
2	Working Tables (2)	1/F Pilot Plant Annex	2 pcs, 3m x 1.5m x 1.5m	1. Voltage reqt: 110V/230V 2. power rating: 1kW 3. 110V/230V Sockets w/ cover
3	Monobloc Stools (8)	1/F Pilot Plant Annex	8 pcs, 2m x 1.5m x 0.7m	
4	Fixed White Board (1)	1/F Pilot Plant Annex	1 pc, 4m x 0.001m x 1.5m	
5	Moveable White Board (1)	1/F Pilot Plant Annex	1 pc, 2m x 0.001m x 1.5m	
6	Sample Cabinets (2)	1/F Pilot Plant Annex	2 pcs, 1.5m x 0.5m x 2.5m	1. Locks
7	Lockers (2)	1/F Pilot Plant Annex	2 pcs, 1.5m x 0.5m x 2.5m	1. Locks
8	Bag Rack (1)	1/F Pilot Plant Annex	1 pc, 2m x 0.5m x 2.5m	
9	Light Equipment Cabinet (1)	1/F Pilot Plant Annex	1 pc, 1.5m x 0.5m x 2.5m	1. Locks
10	Ventilator (4)	1/F Pilot Plant Annex	4 units, 1m x 1m x 1m	1. Voltage reqt: 230V 2. power rating: 1/4 HP 3. Roof-mounted
11	Dust Collector (1)	1/F Pilot Plant Annex	1 unit, 1m x 1m x 1.5m	1. Voltage reqt: 230V 2. power rating: 1/2 HP 3. Roof-mounted
12	Tiled Concrete Tables (4)	1/F Pilot Plant Annex	4 pcs, 3m x 1.5m x 1.5m	1. Voltage reqt: 110V/230V 2. power rating: 1kW 3. 110V/230V Sockets w/ cover
13	Falcon SB40 Concentrator	1/F Pilot Plant Annex	1 unit, 1m x 1m x 2.5m	1. Voltage reqt: 230V 2. power rating: 1 + 1/4 HP 3. Mounted on 1-m table
14	Gyratory Crusher (1)	1/F Pilot Plant Annex	1 unit, 1m x 1m x 0.7m	1. Voltage reqt: 2. power rating: 3. Raised on 1-m platform
15	Flotation Cells (2)	1/F Pilot Plant Annex	2 units, 2.5m x 1m x 2m	1. Voltage reqt: 220V 2. power rating: 1/4 HP
16	Ball Mill (1)	1/F Pilot Plant Annex	1 unit, 2.5m x 1.5m x 1.5m	1. Voltage reqt: 110V/230V 2. power rating: 1kW 3. 110V/230V Sockets w/ cover
17	Jaw Crusher (1)	1/F Pilot Plant Annex	1 unit, 1m x 1m x 1.5m	1. Voltage reqt: 2. power rating: 3. Raised on 1-m platform
18	Electric Muffle Furnace	1/F Pilot Plant Annex	1 unit, 1m x 1m x 1.5m	
19	Rotap Machine	1/F Pilot Plant Annex	1 unit, 0.7m x 0.7m x 1.2m	1. Voltage reqt: 220V 2. power rating: 186W 3. Raised on 1-m platform
<b>MSMRL-Datamine Facility</b>				
1	desktop computers, 15 units	3/F Pilot Plant Annex		



<b>Optical Microscopy Laboratory</b>				
1	CCD Camera for Microscopes	1/F Main Building	2 pcs	1. Voltage reqt: 220V
2	desktop computers for microscope interface	1/F Main Building	2 pcs	1. Voltage reqt: 220V 2. power rating: 600 W
3	metallurgical microscope w/ digital image capture /pc interface	1/F Main Building	1 pc	1. Voltage reqt: 220V 2. power rating:600 W
4	Sturdy working tables	1/F Main Building	4 pcs	
<b>Thermal Analysis Laboratory</b>				
1	Dilatometer	1/F Main Building		
2	Dynamic mechanical analyzer	1/F Main Building	0.5m x 0.5m x 0.5m	1. Voltage reqt: 2. power rating:

