UNIVERSITY
of
GLASGOW

School of Engineering

Laboratory Practice and Safety Notes for the Cleanrooms in James Watt Nanofabrication Centre (JWNC)

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1 Introduction

The standard response to the subject of safety is often "this is really basic common sense - stop boring me with this nonsense and lets get on with the interesting things I've come here to do". Most people completely switch off when safety is discussed and there is a general attitude that "it will NOT HAPPEN TO ME - I'm careful". Unfortunately the unthinkable has happened with the most serious consequences for people and property.

1.1 WHY BOTHER ABOUT SAFETY?

There are a number of very good reasons why we ALL need to pay much more attention to lab safety. One of the most important reasons is under the Health and Safety at Work Act 1974 we are now all legally responsible for the safety of OURSELVES and the safety of others. This means that you could conceivably act in a dangerous manner and injure only yourself and be prosecuted for doing so. We are also responsible for the safety of others and we must not expose them to danger from either from something we ask them to do or something which we are doing ourselves.

In the same way as motorists are required to understand and pass a written and practical driving test, all of the university laboratories are now required to have clear guidelines or rules governing the lab procedures. This drive to improve safety is being pursued by the government, the university safety service, School safety groups and by the staff who run the university laboratories. In The United Kingdom severe penalties are often applied for breaches of safety regulations and for failures to make personnel aware of hazards which affect their well-being.

2 General Safety Issues

In The United Kingdom the emergency services are normally summoned via the public telephone network by dialling 999. The University of Glasgow operates a very large telephone exchange with limited access to the public telephone network. Throughout the university the emergency services can be summoned from ANY land-line telephone by dialling **4444 .** The operator or security guard will ask you what emergency assistance you need e.g. ambulance, fire brigade or police services.

In an emergency it is easy to panic. Please try to remain calm and give clear instructions as to the type of help you require AND, very importantly, the EXACT LOCATION where help is required. Make sure that responsible laboratory staff are made aware of the situation immediately. In the JWNC a number of staff are trained in basic First Aid. Make sure that you know who the trained first aiders are in the area you are working. Contact names and numbers are displayed in the front office of the JWNC. Basic First Aid Kits are available throughout the JWNC. Please make sure that laboratory staff are informed if any items are removed from these kits since they need to be kept fully stocked at all times. All accidents MUST be reported to laboratory staff, the School of Engineering Safety Co-ordinator and an accident report form needs to be completed (see www.gla.ac.uk/SEPS/ and look for 'Report an Incident' for details). All teaching and research personnel are requested to attend a training session on fire fighting every few years.

3 Access to Laboratories

Various conditions apply to laboratory access depending on the laboratory and the time of day. Access to all cleanrooms and fabrication laboratories within the James Watt Nanofabrication Centre (JWNC) is carefully controlled. ALL users of these facilities need to do the following BEFORE they are permitted to work unsupervised in any of these laboratories.

- Attend a safety talk on general lab practice/safety or watch the on-line video
- Read through this document and successfully answer the accompanying questionnaire
- Read through the risk assessment forms relevant to the work they intend to do (see section 6.9 on risk assessment forms)
- Sign the relevant risk assessment documentation for EACH laboratory they plan to work in.
- Agree to abide by the School of Engineering Safety regulations (see the School website for details - http://www.gla.ac.uk/schools/engineering/informationforstaff/safety/)
- NO FOOD OR DRINK MAY BE CONSUMED IN ANY OF THE LABORATORIES including computer laboratories.

Door access to the JWNC is electronically controlled and the door entry system makes use of standard university staff cards which can be programmed to allow entry. Card authorization can be arranged by JWNC technical staff during the registration process or at any point thereafter. Note that under no circumstances should any of the electronic doors be propped open even for a short time. Similarly, users should not allow anybody other than authorized card holders to enter the laboratory and door access cards should not be used by anyone other than the person the card was issued to. Breaches of these rules are taken extremely seriously and may result in restricted access.

New users will be issued with a blue cleanroom suit and boots. Please note that in October 2018 we are introducing new instructions for appropriate attire in the clean room. In summary, this involves the use of a full clean room suit (please note that the wearing of snoods is no longer deemed appropriate and should be replaced by a full clean-room suit hood), clean room boots worn over the trouser leg of the clean-room suit, nitrile gloves and a face mask.

Undergraduates working on final year fabrication projects which make use of fabrication equipment within the JWNC are permitted to enter the JWNC if accompanied by a member of staff.

3.1 New and Expectant Mothers (Pregnant Women)

Without exception, all new and expectant mothers must review all their risk assessments for the work they are doing in the JWNC. This review must be completed with their supervisor. It is also necessary to inform:

- their supervisor(s) and,
- persons in charge of the laboratory where they are working (either the Director of Operations, or the Director of the JWNC)

that such a review is required. Once the review is completed, partial access to the clean rooms will be granted. Access to certain areas will be withdrawn such as the resist spinning rooms and areas where certain solvents are in use.

In addition to these JWNC specific instructions, new and expectant mothers are encouraged to review the contents and advice of the University Safety and Environmental Protection Services web site (http://www.gla.ac.uk/services/seps/az/newandexpectantmothers/).

3.2 Working in laboratories outwith normal working hours

Special arrangements are in place for the JWNC and users can only use the facility after agreeing to abide by these rules (see separate documentation). To work outwith normal working hours you must agree that you will ONLY work in the laboratory if there is at least one other authorised person in the vicinity at the same time. In the late working book you must name the individual who will be providing safety cover for you. Please note that starting September 2018 there will be no out-of-hours access to level 2 of the JWNC. This situation will remain in place until the construction project is completed in the first half of 2019.

3.3 Emergency Access to laboratories

Should access be required to a laboratory outwith normal working hours because of an emergency such as a flood, please phone the university security on EXT 4282. They will contact key holders to inform them of the emergency and obtain expert help.

The JWNC the electronic doors automatically unlock if there is a fire or gas alert. Note also that modern fire regulations require that the glass window at the top of the stairwell automatically opens to release any smoke from this area.

3.4 Restricted Areas and Access

In the JWNC all plant rooms are restricted access areas and are not open to users. The mezzanine plant area is also a hard hat restricted area. The external gas cages at the rear of the building are also restricted access areas and not open to users. If you particularly wish to visit these areas then technical staff will be happy to assist you.

It is essential that all external gates, external plant room doors and all front door access to the lab are locked every evening. It is critical that we maintain the security of our laboratoty at all times.

JWNC staff will therefore do a daily check to ensure that all doors of the lab are closed before they leave at the end of the working day.

Please note that under no circumstances should any users leave any of the electronic doors propped open. Such actions compromise building security and exposes our design lab computer equipment to particular risk and can be tracked through the computer controlled door entry system. Depending on circumstances, if a user is discovered to have intentionally left any of these doors open access to the JWNC may be withdrawn.

4 Fire Safety

4.1 General points on fire safety

Unfortunately there have been a number of fires within the School of Engineering over the years and, in one serious incident several years ago, a cleanroom was completely destroyed. Thankfully nobody was hurt in this incident. However, this was not the case a few years later when an experienced research assistant was engulfed in flames after he ignored safety procedures. He then spent more than two weeks in the burns unit of the Royal Infirmary in Glasgow.

Every room within the JWNC has either a flame or a smoke detector fitted and if any of these units are activated the fire alarm is automatically tripped and the fire brigade summoned. Please note that there is a NO SMOKING POLICY within the University and the detectors have been known to respond to cigarette smoke. School staff test periodically check the fire detectors and test the alarm FOR A FEW SECONDS every Thursday. The fire alarm can also be activated manually by breaking the glass in any of the red sensors marked "fire alarm " which are located throughout the building.

The fire alarm is a loud siren. If the siren sounds for more than a few seconds then IMMEDIATELY stop what you are doing and head for the muster point located outside the building. DO NOT wait until you are finished what you are doing, for example, the final processing step on your sample or removing your substrate from the SEM. You should NOT stop to remove your cleanroom suit unless instructed to do so by laboratory staff. Delaying your response to a fire alarm is unaccepatble.

4.2 Fire Prevention

There are a number of steps which you can take to minimise the risk of fire:

- In computer rooms, offices and labs please make sure that waste paper is not allowed to accumulate around computers and printers.
- In laboratories make sure that no combustible materials are placed close to hot plates and soldering irons. DO NOT use acetone or any other flammable liquid in the vicinity of hot plates or other sources of ignition.
- ALL flammable liquids should only be used in a fume cupboard.

- Organic solvents should ONLY be stored in fridges which are explosion protected. A few years ago there was a serious accident in a local hospital when a fridge containing chloroform blew up.
- Organic solvents should be stored in proper metal storage cabinets and only the minimum of solvents should be stored in each laboratory. Larger volumes of solvents should be stored in the chemical store.
- Turn off all hot plates and soldering irons after use.
- Where possible switch off all computers and if you are last to leave a laboratory make sure that ALL room the lights are turned off. Over the years there have been several instances when light fittings have overheated and have started to smoulder.
- A number of laboratories and rooms have local arrangements for keeping equipment running overnight and for leaving the laboratory in a safe condition. Please make sure that you comply with these local arrangements.
- Please also make sure that fire doors at the end and middle of corridors are kept shut. These form an important part of fire defences and should NOT be left wedged open after floor cleaning or the movement of large pieces of equipment.

4.3 What to do if a fire starts

Don't panic. Call for help and try to assess whether the fire can be extinguished using a fire extinguisher. If you have any doubts about this or are uncertain as to which fire extinguisher to use, err on the side of caution and break the glass at the nearest fire alarm call point. The fire brigade will arrive. In addition, call security on 4444 from any university land-line phone and give them details of the incident.

Fire extinguishers

Several types of fire extinguisher are available for use and they are regularly checked. It should be noted British Standard fire extinguishers are coloured depending on the type of extinguisher. For example carbon dioxide extinguishers are black in colour. Recent European legislation means that ALL new fire extinguishers will be red with a small coloured band or box identifying the type of extinguisher. The type of extinguisher will also be written on it in a colour associated with the type of extinguisher.

- Carbon Dioxide Extinguisher

This is regarded as a general purpose fire extinguisher. The extinguisher is activated by removing the locking pin, positioning the nozzle and pulling on the lever. The extinguisher produces a high pressure stream of carbon dioxide which should be directed at the base of the fire. The extinguisher depletes the fire of oxygen and also cools the source of the fire. This is suitable for electrical fires.

- Dry Powder Extinguisher

Releases a stream of fine powder which is used to smother the fire. Please note that when this type of extinguisher is used there is a possibility that the fire detection systems will be activated (if they haven't already triggered) by air borne powder from the extinguisher.

- Fire Blanket

An extremely effective method of smothering a clothing fire and most certainly saved the life of the research assistant mentioned above.

4.4 Emergency evacuation of the cleanrooms

If a fire or gas emergency arises in one of the cleanrooms you should evacuate the laboratory as quickly as possible . You should not change out of your cleanroom suit unless instructed to do so by staff.

Please take time to examine the fire escape document shown in Appendix 1. This shows the layout of the JWNC cleanroom suite. Pay particular attention to the location of exits. This fire escape plan is in effect during a period of construction outside level 2 of the JWNC. Please note that during this period of construction, no out-of-hours access is permitted on level 2 of the JWNC.

Note that in the event of a fire or gas alert the electronic doors should automatically unlock. If this does not happen then it may become necessary to activate the door lock in the usual way by pressing the appropriate door release button. If in the unlikely event this does not work then the door can be opened by breaking the green emergency break glass panel alongside each door release switch. When you leave the JWNC during a fire or gas alarm you should assemble at the muster points which are at Pearce Lodge, outside the main entrance to the James Watt Engineering Building or outside the entrance to the JWNC.

5 Gas Safety

The JWNC contains many plasma processing systems which are used to etch and deposit different types of materials. The systems rely on the use of various gaseous reagents and these reagents are housed in dedicated gas cabinets located in the proximity of the laboratory. The gases are delivered to the various plasma processing systems via dedicted stainless steel pipework. There are a wide variety of gases used (see JWNC Wiki) and they are either toxic, asphyxiants, explosive, corrosive or irritants even in very small concentrations. As a result it is very important that our staff are diligent in assuring the leak integrity of our equipment and also in deploying very sensitive gas detection systems which will warn us of any leaks that may occur before they can reach a harmful level.

The gas detection system will sound an alarm when certain gases are detected, when this alarm is heard, the lab should be evacuated immediately in the same manner as described for a fire alarm. In addition to the audible alarm generated by the gas detection system there are also ‘traffic light’ style beacons located in the following areas:

- Outside the extrance to the main changing room
- On the ceiling of the plasma processing lab
- On the wall outside the cluster tool room
- On the wall outside the SPTS room in the expansion area
- On the wall outside the high temperature process room in the expansion area
- At both entrances of the plant room that supports the expansion.

These traffic-light style indicators will be illuminated in one of three states:

- Green: Situation normal, no alarms.

- Amber: Either an equipment fault or a sub-threshold alarm. In this state the lab is still safe however technical staff will be investigating the cause of the fault. No audible alarm will sound.
- Red: Thresholds have been triggered, auudible alarm will sound and users should evacuate the lab in the same manner described above for a fire alarm.

Additionally, red-only style gas alarms are located in the following locations:
- Outside the plasm processing lab
- Outside the metal dep lab
- Outside the chemical prep lab
- On the ceiling outside the VB6 room on L2.

When these red-only style gas alarms have been triggered, an auudible alarm will sound and users should evacuate the lab in the same manner described above for a fire alarm.

6 Control of Substances Hazardous To Health (COSHH)

A fundamental requirement of the Control of Substances Hazardous to Health Regulations (1994) is that exposure of employees to substances hazardous to health should be prevented or, where this is not reasonably practicable, adequately controlled.

It is for these reasons that all laboratory procedures used within the university are assessed for risk. The results of risk assessments are recorded on risk assessment forms. All lab users must read the relevant risk forms and sign a document that acknowledges they have done so. Laboratory staff will issue lab users with relevant risk forms and paperwork before they begin to work in the laboratory. A number of terms are commonly used to describe substances and some are referred to in these forms.

6.1 Flammability

Liquids are classified as being extremely flammable, highly flammable or flammable depending on their flash point. The flash point is the lowest temperature at which a chemical will in the presence of air and an ignition source, ignite.

Description of liquid	Flash point	Example
Extremely flammable	below 0˚C	Acetone (-20˚C)
Highly flammable	0˚C to 21˚C	Propan-2-ol (12˚C)
Flammable	21˚C to 55˚C	o-xylene (31˚C)

Please also note that vapour/air mixtures can be explosive. For example, a mixture of 3-13% acetone in air is explosive. Solvents can also auto ignite above certain temperatures and in the absence of a source of ignition. The auto ignition temperature for acetone is 538˚C.

Clearly it is important to ensure that organic solvents are used and stored correctly.
In the laboratory flammable substances are identified by the label

6.2 Toxicity

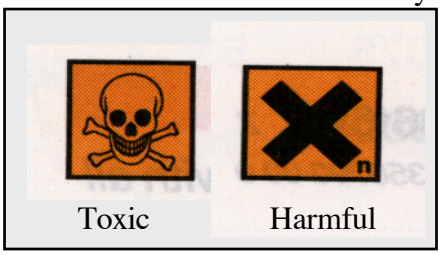
Substances are defined as being either very toxic, toxic or harmful. These classifications are based on the results of animal experiments and may only be taken as an indication of human toxicity. In some cases the information can be misleading and it should be emphasised that the toxicity of mixtures of substances can be greater than for individual substances. Terms which are commonly used to quantify levels of toxicity are defined as follows :-

LD50 - the dose which causes death in 50% of test animals when administered orally or through the skin.
LC50 - the concentration in air which causes death in 50% of test animals.

These are used to define substances as very toxic , toxic or harmful as follows :-

Toxicity rating	**LD50 absorbed orally in rat (mg/kg)**	**LD50 absorbed through skin in rat or rabbit (mg/kg)**	**LC50 absorbed by inhalation in rat (mg/litre over 4hrs)**
Very Toxic	25	50	0.5
Toxic	25-200	50-400	0.5-2
Harmful	200-2000	400-2000	2-20

In the laboratory toxic and harmful substances are identified by the following labels.



Most people are aware of the dangers of swallowing or inhaling toxic substances but do not fully appreciate the dangers of skin absorption. It is therefore essential that gloves are worn at ALL times when handling substances within laboratories. Any spillage's on unprotected skin should be removed immediately with soap and water.

6.3 Other terms used to define substances

A number of other terms are frequently used to describe chemicals and particular attention should be paid to these since they warn of possible long term health problems if the substances are incorrectly handled.

Carcinogens - Known to cause malignant cells in animals - e.g. benzene

Mutagens - Substance which raise the frequency of mutations above the normal level.
Many are carcinogenic. An example is methyl iso butyl ketone (MIBK).

Teratogens - Substances which in pregnancy produce or induce a physical defect in the embryo, foetus or offspring. An example is methyl iso butyl ketone (MIBK).

6.4 Exposure Limits And The Law

It is clearly difficult to compare the toxicity effects of chemicals on animals to that of humans. Care has to be taken not to impose impractical exposure limits which are over cautious, perhaps impracticable and consequently do not get implemented. On the other hand it is important that where certain chemicals are known to create health problems maximum exposure limits are set and strictly adhered to. A number of scientific advisory bodies advise the government on exposure limits for employees. This information is published in a document called EH40 which is published each year and is available from HMSO. It should be noted that THIS IS THE LAW and the publication makes this quite clear.

The COSHH Regulations (1994) define TWO types of exposure limit namely :-

a) O.E.S. :an occupational exposure standard

b) M.E.L. :a maximum exposure limit

A substance is given an O.E.S. if it satisfies ALL of the following three conditions :-

Condition 1
Available scientific evidence indicates that the substance is unlikely to be injurious to employees health if they are exposed to it by inhalation every day, at a concentration which is referenced, over fixed period of time. The document EH40 quotes the Time Weighted Average over 8 hour periods for a wide range of chemicals. For example the TWA (8hrs) for methanol is 260 mg/m^3.

Condition 2
Available scientific evidence shows that short term exposures to higher concentrations of the substance are unlikely to produce short or long term health problems. This slight relaxation in the exposure limits allows problems such as leaks in equipment to be identified and remedied. The short term exposure limit for methanol (S.T.E.L.) in15 minutes for methanol is 310mg/m^3.

Condition 3
Available evidence shows that compliance with the OES limits is practicable.

A substance is usually assigned a maximum exposure limit (M.E.L.) if it fails to meet all three criteria for the O.E.S. or if it is liable to have serious health implications for workers. Typical examples of this are hydrogen cyanide and benzene.

6.5 Corrosive Substances

Corrosive substances include strong acids and alkalis. Serious burns can result if these substances are handled incorrectly. The result of skin or eye contact are usually obvious and very painful. Should an accident occur wash the affected area with copious amounts of water and seek medical attention. The JWNC is fitted with emergency eyewash and full body showers (locations shown in the maps in appendix I). If necessary, use these to wash the affected areas.

6.6 Safety precautions when handling chemicals

All suppliers of chemicals are obliged to provide clear information highlighting all the hazards associated with chemicals they supply. This information should ideally come with the delivery and should ALWAYS be read carefully. One example of why this is important arose when somebody acquired several industrial resist strippers for test purposes. It was then discovered that when one of the strippers was mixed with acetone there was a violent exothermic reaction. Since fabrication procedures involve the use of significant quantities of acetone this could have created a serious safety issue. The resist stripper was returned to the manufacturer.

Laboratory personnel should always be consulted BEFORE any chemicals are purchased in order to ensure that it is safe to use within the laboratories and that storage and disposal of the chemical does not create problems.

Fume cupboards are designed to provide a curtain of air across the front of the cupboard and to extract limited quantities of fumes from the work bench. The performance of all fume cupboards within the university is checked independently every few years. Please note that the performance of fume cupboards greatly depends on how far the fume cupboard window is opened and that it is important the window is not raised by more than a few inches above the work bench. This also provides protection when spinning substrates with resist. If used correctly all the fume cupboards will satisfy exposure limits for the substances used in standard fabrication procedures.

Do NOT be tempted to try to find out what is in a beaker by placing your nose near it and sniffing the contents. A number of serious accidents have been reported in laboratories as a result of this. One particular incident involved Hydrofluoric Acid (HF).

6.7 Handling Liquids.

It is thus ESSENTIAL that suitable gloves are worn at ALL TIMES when handling ALL liquids.

Under NO circumstances should you pipette liquids using your mouth. You MUST use a pipette bulb at all times.

ALL Winchesters of acids and solvents should be carried in the wire basket holders provided. This is particularly important if you have a need to transfer Winchesters between labs either on the same floor or on different floors.

Large open beakers of liquids should NOT be carried around the lab and ALL solvent bottles and glassware containing solvent should, as far as possible, be kept inside the fume cupboard.

Samples soaking in solvents should NOT be abandoned in the fume cupboard. If it is necessary to leave samples in containers of solvent, it is ESSENTIAL that the contents of the container and the sample owner are clearly identified with contact details.

All containers of liquid placed in refrigerators MUST be placed upright since there is a serious risk of fire if solvents leak from the fridge. Fridges are fitted with spark free motors. UNDER NO CIRCUMSTANCES should open beakers of ANYTHING be placed in fridges. Everything placed in fridges MUST BE CLEARLY IDENTIFIED with its description and its owner. Any liquids found without labels will be discarded.

Pouring liquids from one vessel to another can be hazardous particularly if you are attempting to pour a small amount of liquid from a large container such as a Winchester into a relatively unstable vessel such as a measuring cylinder. Such liquid transfers should ONLY be done by pouring liquid firstly into a reasonable sized beaker and then pouring the contents of the beaker into the measuring cylinder. ALL spillage's should be cleaned up using a texwipe. Serious spillages should be reported to lab staff immediately. In the event of a large spillage of acids/alkalis or solvents each cleanroom has a drum of absorbing granules which can be used to soak it up. Make sure that lab staff are kept informed if it is used.

Diluting an acid with water can be hazardous since the hydration of certain acids such as sulphuric acid is highly exothermic. This means that you SHOULD NOT add water to acid since the heat of reaction can turn the added water to steam. The steam can then blow the concentrated acid out of the container which is very dangerous. ALL acid dilutions should be carried out in a slow controlled manner adding ACID TO WATER. Any user working with acids must wear goggles (or visor) and gloves. The fume cupboard window should also closed down as far as possible.

In the unlikely event that you get splashed with acid, wash the affected area with copious amounts of water. If necessary use the showers located within the cleanroom or plant area. If you are unfortunate enough to get acid into your eyes, you may find it easier to use one of the emergency eye baths. SEEK MEDICAL ATTENTION.

Should you have a need to use hydrofluoric acid (HF) you MUST wear a plastic apron, a visor and you must obtain a pair of HF resistant gloves from lab staff. These gloves are not disposable and resist 48% HF for 159 minutes according to the manufacturers specifications. You should also make it quite clear to anybody working around you what you are doing and you MUST work alone in the fume extraction cupboard. Aqueous HF readily attacks glass and silica and so it is important to use ONLY plastic vessels - preferably made of PTFE.

After you have finished using the HF ensure that it is stored correctly. Thoroughly wash your gloved hands under the taps after use. Hydrofluoric acid burns are often very severe as HF dissolves skin. Burns from hydrofluoric acid are sometimes difficult to detect immediately, so if you get some splashes of HF on your skin you should contact lab staff immediately after you have washed it off. It may be necessary to seek medical assistance. Lab staff have been advised to issue a tube of HF antidote gel to anybody suspected of having HF burns since the effects of the burns can become apparent several hours after the incident.

Similar practices are in place for the handling of Tetra-Methyl Ammonium Hydroxide (TMAH) which is an alkali, please consult risk assessment forms for details.

It might seem rather obvious but it is ESSENTIAL that once solvent, acid or alkali are removed from a reagent bottle then NO attempts should be made to return any of the liquid to the reagent bottle. There are a number of reasons for this. Firstly, it is just possible that you have mixed up solutions with the result that you could be adding water to acid or acetone to IPA. Apart from the

possible safety hazards which may arise, there is a possibility that another lab user may destroy patterned resist coatings because of contamination. Furthermore, glassware is often not scrupulously clean and any contamination from the glassware may contaminate the contents of an entire reagent bottle.

6.8 Disposing of Liquids

Ensure that all waste liquids are disposed of correctly. Acids should be disposed of as follows:

- Fill a large beaker with water and slowly pour a small quantity of the acid into the beaker.
- Pour the entire contents of the beaker down the sink and THEN turn on the taps to wash the diluted acid away.
- Repeat this procedure until the entire quantity of acid is disposed of.

You SHOULD NOT place a beaker of acid into the sink and turn on the taps. There is a serious risk of acid splash burns if you do this. Similarly you SHOULD NOT pour concentrated acid down the sink and then turn on the taps.

An alternative method of acid disposal is to fill the sink with water, add the acid to the filled sink and then empty the sink. Then carefully run the mains water taps for a while after this.

The university strictly controls the disposal of organic solvents from all of its labs. For reasons of safety it is necessary to distinguish between chlorinated wastes and unchlorinated wastes. Consequently, fume cupboards are each fitted with 2 liquid disposal chutes, one for unchlorinated wastes such as acetone, methyl iso butyl ketone (MIBK) and iso propyl alcohol (IPA) and the other for chlorinated wastes. The waste solvents discarded down the chutes are collected in drums at the rear of the cabinets. These drums of waste are subsequently disposed of in a controlled manner.

A recent incident in the university illustrates the potential hazards which can arise when liquids are not disposed of correctly. The Rankine Building and at least two other buildings on the university campus were evacuated and the emergency services called when an individual in another department elsewhere on campus emptied a foul smelling chemical down the domestic drain.

6.9 Electronic Risk Assessment Forms

Users who wish to introduce a new process to the JWNC must take the responsibility of submitting a risk assessment form and ensuring it completes the approval process before the process is implemented. The School's policy on risk assessment forms is that all new forms are to be completed electronically. This can be done following links on the School safety website, where completed forms which can be browsed. Before you complete an electronic risk form you should obtain copies of the relevant MSDS so that these can be uploaded with the assessment. When you submit your completed form it is initially added to a database and checked. If the form has been completed satisfactorily it is then authorised and published.

6.10 Miscellaneous Safety Matters

6.10.1 The use of lasers

A wide variety of different types of laser are used in the School and some of these could result in serious eye damage. The university has a strict policy on the use of lasers . Anybody wishing to gain access to a laser must register and view a laser safety training DVD. Rooms with lasers have

the classification of the laser marked on the door. Safety goggles should be worn where appropriate and laser / door interlock alarms should not be disconnected.

6.10.2 Sharps Disposal
All used microscope slides and cover slips should be deposited in the sharps bin beside the fume extraction cupboards. Waste Gallium Arsenide (GaAs), Indium Gallium Arsenide (InGaAs) and Indium Arsenide (InAs) should be deposited in the 'Junk Gallium Arsenide' beaker. This is important since III-As materials are toxic and a suspected carcinogen.

6.10.3 Wire Stripping
While wire stripping may seem a fairly harmless activity, it has resulted in a number of accidents in the school - one of which needed hospital attention. When stripping the insulation off a piece of wire DO NOT use a scalpel or any other improvised tool. Use a pair of wire strippers and DO NOT UNDER ANY CIRCUMSTANCES hold any other tools such as screwdrivers in your hands while doing this. Strip the wire by pushing the wire strippers away from you. It is surprisingly easy to damage your eyes or face while carrying out this activity.

6.10.4 Interfering with equipment
Some of the equipment in the fabrication laboratory represents a real hazard to health and safety if tampered with. No attempts should therefore be made to remove instrument panels or reset equipment operating conditions. This particularly applies to the Plassys evaporators. In an emergency the Plassys evaporators can be closed down by pressing the large emergency stop button on the front panel.

6.10.5 Moving Equipment
A number of injuries have resulted from attempts to move heavy equipment without supervision and in one case this almost resulted in part of a finger being severed. Heavy equipment should ONLY be moved after consultation with lab staff who will decide if it is necessary to consult staff trained in this activity.

6.10.6 Office accidents
Offices can also be a source of accidents. Recently somebody had to visit the local accident and emergency unit after their face came into contact with scalding hot coffee..

6.10.7 Latex and Latex associated allergies
Latex gloves are used in several cleanroom activities and it should be noted that in recent years, latex sensitisation has become increasingly recognised. Only a couple of cases have been observed in the School over the past ten years however the university Safety and Environmental Protection Services have now produced a safety note warning all university employees of possible allergic reactions to latex materials.
Latex gloves provide relatively good protection against many of the chemicals used in the cleanrooms and for the time being will continue to be used. All laboratory users should however be aware of the possible risks from allergies and should immediately report any suspected allergic responses to laboratory staff.

6.11 CLEANLINESS

All cleanroom users MUST wear the cleanroom clothing provided and follow the recommended cleanroom practices. The cleanroom cabinets are fitted with class 100 hepa filters and a curtain of filtered air is blown down over the front of each cabinet. It is in everybody's interests to work in the

cleanroom as cleanly as possible. The JWNC is presently working on a number of contracts with companies in the electronics industry and so it is even more important that we meet their very high standards of cleanroom practice.

Remove any heavy sweaters BEFORE entry to he cleanrooms. Inside the changing rooms, check that your cleanroom suit is in a satisfactory condition before putting it on. You will be issued with a replacement suit should you need it. After you have finished working in the cleanrooms, ensure that you put your shoes in the separate suit and shoe storage areas as this minimises contamination. All of the cleanroom filtered air flows are carefully balanced and in order to minimise room contamination it is important that you DO NOT open more than one cleanroom door at a time.
The JWNC class 10 cleanroom suites is out of bounds to everybody except beamwriter operators.

7 Information on the JWNC

Once registered for the laboratory you will be issued with a username and password to gain access to the JWNC internal website. This web site will enable you to book equipment, report faults and processing problems for equipment on which you have been trained. The JWNC website contains lots of information on how to use all of the capabilities in the JWNC, the picture below shows the main menu:

To ensure technical staff receive user feedback on tool performance, the booking of plasma process equipment will require the user to provide feedback to staff on the run that was performed. The web site is a source of tool status and equipment information including performance data and a record of your equipment bookings. Equipment can only be booked once you have been authorized by staff and this only happens once staff are satisfied you have received the appropriate training from a registered equipment trainer.

8 Summary

- Accidents will happen when you least expect them.
- You have legal responsibilities for your own safety and the safety of others around you.
- Fire safety is extremely important and you should take time to examine the information explaining fire fighting equipment and exit routes.
- Chemical safety is equally important and the School has well defined procedures for handling and disposing of chemicals.
- Before you gain access to School fabrication laboratories you must complete the safety questionnaire, read relevant risk assessment forms, and sign a document stating that you have read them and agree to abide by the rules.

Should you be concerned or unsure about ANY aspect of lab safety or indeed this document, please do not hesitate to contact lab staff.

JWNC Executive
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Appendix 1 - Lab layout and escape routes