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| **UNIVERSITY OF BRISTOL SCHOOL OF CHEMISTRY**  **RISK ASSESSMENT**  **This form must be completed by a competent assessor for any procedure/system of work before an attempt is made at carrying out the procedure/system of work. Please refer to the instructions for making a Risk Assessment in the** [**School of Chemistry Safety Manual**](http://www.chm.bris.ac.uk/safety/nfrass.htm) **(http://www.chm.bris.ac.uk/safety/nfrass.htm).** |
| **Name and Status of the Assessor:** James Smith (Research Officer) & Paul May (Lab Manager) **Date:** 02/03/2025 |
| **Activity/procedure being assessed:**  **Use of Tube Furnace (S111)** |
| **Known or expected hazards associated with the activity:**   1. Explosive gases 2. Exposure to elevated temperatures 3. Explosion hazard (in case of vacuum failure while reactor is operating) 4. Vacuum apparatus (implosion hazard) 5. Organic solvents (highly flammable) 6. Silicon/diamond substrates |
| **The risk of injury and its severity likely to arise from these hazards:**   1. The risk of injury due to the escape of hydrogen (flammable; explosive) is low in the same sense that the risk of any gas escape is low, as the equipment has been designed with the use of hydrogen in mind. The risk of a leak going unnoticed is very low, but unchecked small leaks could result in the formation of an explosive atmosphere. Care must be taken while operating the equipment, monitoring the pressure within the tube is essential. 2. Care should be taken not to handle the quartz tube while the tube furnace is hot. On completion of a run some components (quartz tube, support posts, gas inlet line and substrate) may still be at a high enough temperature to cause skin burns, users are advised to wait until the parts have cooled sufficiently before removing the substrate or making changes to the internal setup. 3. The risk of explosion due to vacuum failure and consequent ingress of air into the reactor while operating (i.e. while containing hydrogen) is low in ordinary circumstances, but could be significant in case of severe failure of vacuum components. An explosion of this sort could result in extremely serious bodily injury. The tube is designed so that over pressurising cannot occur, but care must be taken to ensure it does not exceed atmospheric pressures. 4. The risk of injury from implosion is very limited since almost the entire apparatus is solidly constructed from quartz. The tube should be checked regularly for any signs of damage or stress. Do not use a tube that shows any signs of weakness. 5. The risk of injury due to a solvent fire is low: the risk of ignition is minimal. The severity of this injury is likely to be low to medium in view of the primary application of solvents for cleaning samples and chamber fittings which requires only very small quantities. The cleaning solvents usually employed are ethanol and acetone, so they pose only negligible toxic hazard. 6. Substrates are normally handled with tweezers to avoid contaminating or damaging them; thus, the risk of cuts is low. Since the sharp objects in question are very small, the potential severity of a cut from them is inherently limited. |
| **Who is at risk?**  Research workers using the apparatus. There is a chance that other people nearby in the laboratory may be affected in the unlikely event of a major incident. |
| **Measure to be taken to reduce the level of risk:**   1. Standard safe working practice must be followed for the handling and use of gases. In particular, special care must be taken when moving or transporting them (especially those containing hydrogen), and only trained persons must attempt this procedure. Regulators must be checked for damage or improper operation each time a cylinder is replaced, since failure could lead to an overpressure condition in the downstream gas line. All fittings must be tested for leaks using bubble solution when first made up and whenever they are disconnected and reconnected. **Safety glasses must be worn when changing gas cylinders as this involves gas at high pressure.** 2. Allow the chamber sufficient time to cool prior to handling the quartz tube or sample. 3. Cylinders of toxic or explosive gases must be kept inside securely closed, ventilated cylinder cabinets, preferably located in the cylinder store room. Exhaust gases pumped out of the reactor must be not be exhausted into the laboratory air, but rather directed via tubing into the air extraction system, which must be verified to operate at a sufficiently high inlet flow rate to rapidly dilute and remove hazardous gases. 4. Extreme care must be taken not to disconnect any parts of the vacuum system while the reactor is in operation. All vacuum fittings must be securely made up, and of such a type as requires deliberate and concerted effort to disconnect. The quality of the vacuum seal must be checked each time the reactor is to be started, by ensuring that the achievable base pressure is sufficiently low as to exclude any hazardous air leak. Care must be taken not to damage or disrupt any connections *e.g.* by rough handling, and no activities that could entail any risk of compromising the integrity of the reactor are to be permitted while it is operating. 5. Cleaning of apparatus and optics must be performed using a minimal quantity of solvent in a well-ventilated area, away from potential sources of ignition. Spills must be cleaned up promptly in order to avoid later accidental ignition. Bulk solvents must be stored in a suitable solvent cabinet, and wash bottles are to be of the vapour-venting type and stored appropriately. Protective gloves should preferably be worn to avoid skin irritation. 6. No further measures deemed necessary. If a cut is sustained, it will be sufficient to wash with water and apply a sticking plaster. 7. **Safety glasses must be worn if the tube furnace is to be operated under reduced pressure**, in case of implosion/explosion. If the furnace is operated at atmospheric pressure, or open to the ambient background air, then there is no risk of explosion so safety glasses are not needed. |
| **Training prerequisites:**  As required in the references. Training in the particular safety aspects of operating the apparatus is intrinsic in the training required in order to operate it in other respects, i.e. without damaging equipment and in order to obtain meaningful results. Untrained persons must not work on the experiment unsupervised. |
| **Level of risk remaining:**  Slight, barring unforeseeable accidents. |
| **Action to be taken in an emergency:**  IN CASE OF INJURY, perform First Aid if trained or contact a designated First Aider. (A current list is provided at the Porter’s Lodge). If necessary, also contact security on extension 112233 (0117 331 1223) and ask to call for an ambulance.  IN CASE OF FIRE, evacuate the affected area, raise the fire alarm, and contact security on extension 112233 (0117 331 1223) to call the fire brigade.  IN CASE OF GAS ESCAPE. If possible, isolate the gas line, evacuate the laboratory and any affected areas; Inform anyone in the vicinity or raise the fire alarm as appropriate, evacuate the affected area, and contact security on extension 112233 (0117 331 1223) to call the fire brigade. |
| **References:**  The following constitute an integral part of this risk assessment and must be reviewed along with the above.  Standard School of Chemistry risk assessments, accessible via Blackboard,   1. The Transport, Storage and Use of Compressed Gas Cylinders 2. Use of Flammable, Explosive and Toxic Gases 3. Use of Reduced Pressure or Vacuum |
| **Signature of Assessor: Supervisor’s signature:**  J.A. Smith & Paul May |