

# Radiation Safety

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## Policy

In accordance with the provisions of the Radiation Ordinance, Cap 303, the University is required to apply for licences in respect of the use of radioactive substances and irradiating apparatus.

For the use of radiation/radioactive substances for clinical purposes, a separate licence must be obtained from the Government Radiation Board for the following categories:

1. To possess and use radioactive substances for clinical purposes.
2. To possess irradiating apparatus for clinical purposes (separate licence for each and every apparatus).
3. To use irradiating apparatus on human body (one licence for each qualified member of staff).

The use of radioactive materials and use of irradiating apparatus is bound by legislation and strict rules and these are illustrated in the guidance that follows.

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## Responsibilities

### *Department Heads must:*

- ensure all aspects of radiation safety as indicated in the Radiation Ordinance are complied with within the department.
- ensure that anyone working with irradiating apparatus or radioactive materials is suitably trained.
- ensure that all users are sent on the biannual Radiation Safety Course unless the Radiation Protection Officer (RPO) has evidence to suggest the user is adequately qualified.

### *The Radiation Protection Officer (RPO) will:*

- ensure, as far as he is able, that the provisions of the Radiation Ordinance, and the regulations made under it, are complied with.
- control all acquisitions and uses of radioactive substances and irradiating apparatus; and disposal of all radioactive waste and irradiating apparatus.
- provide advice on radiation protection.
- in consultation with the Director of the University Health Service classify personnel into Designated Radiation Workers (DRWs) or Designated Radiation Users (DRUs) and determine and/or provide the required protection and monitoring procedures.

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- supervise, administer, regularly examine and report as necessary to Council, through the Committee on Health, Safety and Well-Being, on the arrangements made for protection and personnel monitoring.
- maintain adequate records of the types and quantities of radioactive substances and irradiating apparatus held in the University and of their fates; and the persons exposed to radiation and the doses of radiation received.
- report through the SHEC to Council for information, and action where necessary, on any particularly hazardous operation proposed, with recommendations for special precautions.

***Departmental Radiation Safety Representatives (DRSR) should:***

- be responsible for the issue and proper use of monitoring devices.
- ensure that records are kept of the usage of radioactive substances.
- supervise the preparation of radioactive waste for collection.
- provide advice to the Head of Department on departmental radiation hazards and to liaise with the RPO.
- arrange annual leak tests for sealed radioactive sources and functional tests for radiation monitors as appropriate.
- inform the RPO of any changes of DRWs or DRUs.
- inform all staff and students within the Department of departmental radiation matters.

***Designated Radiation Workers/Users (DRWs/DRUs) should:***

- comply with all requirements and conditions associated with designation.
- ensure that radiation exposure to all persons (including oneself) is kept as low as reasonably achievable (ALARA principle) and in any case below the current dose limits recommended by the International Commission on Radiological Protection (ICRP).
- participate in the medical surveillance and personnel monitoring arrangements. (Failure to take the necessary examinations on schedule may lead to suspension of designation.)
- maintain records of the usage of radioactive substances.
- report herself immediately to a doctor in the University Health Service in case of pregnancy or suspected pregnancy.
- inform the DRSR and/or RPO immediately of any change in the nature of work.
- inform the DRSR and/or RPO as early as possible prior to termination of radiation work or resignation.
- report immediately to the DRSR and/or RPO any untoward incidents which may introduce a radiation/contamination hazard.

***Staff and students should:***

- familiarize themselves with University radiation safety regulations.
- refrain from unauthorized radiation work and/or entry to Controlled Radiation Areas.
- report all suspected radiation accidents and any irregularities in radiation protection services to the departmental or section head.
- suggest improvements for radiation safety to the RPO.

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# Guidance

## 1. General Provisions

1.1 Access to [Controlled Radiation Areas](#) (CRAs) and Irradiating Apparatus is strictly prohibited unless permission has been granted by the RPO or the DRSR in the case of maintenance service, etc.

1.2 Those who work in approved CRAs or work with Irradiating Apparatus must apply for designation via website <http://www.hku.hk/local/radioiso/rpframe.htm>. Additional information is available from the Safety Office, Radiation Protection Unit, Room 402, James Hsioung Lee Science Building (tel. 28592547/22415073 or e-mail: [rpuso@hku.hk](mailto:rpuso@hku.hk)).

1.3 The granting of designated status is not automatic and it may be necessary for applicants to attend a short training course <https://www.safety.hku.hk/training> and/or take a test on radiation protection. When designation is granted, it normally relates to a specific project with an approved scheme of work to be carried out in named premises. A personnel radiation monitoring device will be issued in those cases where such monitoring is appropriate. Costs for these devices are chargeable to departmental budgets.

## 2. Requisitions for Radioactive Materials and Irradiating Apparatus

2.1 All orders for radioactive materials and irradiation apparatus must be approved by the RPO before dispatch to the supplier. This approval is normally granted immediately provided that

- each item is identified for the use of a designated worker;
- its specification is within the approved scheme of work; and
- all designation conditions have been met.

Goods received without such prior approval may not be released to the department concerned.

2.2 Requisitions may be sent direct to the Safety Office for approval and onward transmission to the Finance and Enterprises Office. Overseas goods require an import licence and removal permit and all requisitions should be marked "Import Licence and Removal Permit Required".

2.3 For radioactive goods not consigned to a local agent, the items will be collected from the airport by the Safety Office staff using a designated vehicle. Information concerning such incoming shipments should be given to the Safety Office with shipment details and expected delivery date and time as early as possible.

2.4 Gifts or samples of radioactive materials brought by hand into Hong Kong or posted directly to a department are subject to confiscation by the Customs Service. Should such materials reach University premises they must be reported immediately to the RPO for appropriate action.

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### 3. Radioactive Waste Disposal

- 3.1 All radioactive waste must be collected in approved and labelled containers under conditions determined by the RPO. A waste collection service is available from the Safety Office. It is the responsibility of the user of radioactive materials to keep proper records of the nature and content of the waste material in each container and to inform the Safety Office when collection is required through our website <http://www.hku.hk/local/radioiso/rpframe.htm>
- 3.2 **Radioactive waste MUST NOT be discharged into sewers or normal rubbish bins.**
- 3.3 The RPO shall take measures to monitor waste disposal.

### 4. Laboratory Monitoring

Each CRA is required to install and operate an appropriate radiation monitor for the work performed therein unless exempted by the RPO. Additionally, air-sampling and surface monitoring will be carried out by Safety Office staff. In the event of significant contamination being located, the persons registered for work in the area are required to undertake the necessary decontamination procedures and to introduce precautions to minimize future similar occurrences.

### 5. Pregnancy

The radiation dose limits prescribed for DRWs/DRUs are not applicable during pregnancy, particularly during the early stages.

DRWs/DRUs who know or suspect that they have become pregnant, must report immediately to a doctor in the University Health Service so that advice may be given and the necessary action taken.

### 6. Use of Thermoluminescent Dosimeters (TLDs)

- 6.1 The dosimeter should be worn on that part of the body expected to be exposed to the highest radiation dose. For certain purposes, supplementary wrist or finger dosimeters may be required. For whole body exposure, the dosimeter may be worn most conveniently on the coat lapel.
- 6.2 When not in use for monitoring purposes, the dosimeter must be stored in a suitable location away from any source of radiation.
- 6.3 Under no circumstances should the dosimeter be opened.
- 6.4 When taking leave for a period of one week or more and upon termination of work, TLD user must deposit their TLD with their departmental office.

### 7. Maintenance and Repair Works

Access to CRAs and radiation machines must be restricted to approved designated personnel. If technicians, electricians, decorators or labourers. (e.g. from the Estates Office or Technology Support Centre) are required to perform a service function, their access must first be cleared through DRSR in the department concerned or the RPO.

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This procedure is necessary to ensure that the service staff are adequately warned and instructed on the possible hazards associated with the job for which they are being called upon.

## 8. Receipt of a Shipment of Radioactive Materials

On receipt of a package of radioactive materials:

- 8.1 Wear rubber or plastic gloves whilst processing the package.
- 8.2 Monitor the outside of the package to determine the radiation field (hard betas/gammas) or possible contamination (soft betas).
- 8.3 Place the package on a tray in a vented hood and verify that the contents on the label agree with original order.
- 8.4 Install suitable shielding around the package (hard betas/gammas).
- 8.5 Open the package and inspect the container immediately after receipt. Delay may mean that vendors will not accept damage claims. Long storage, possibly in an inverted position, may also cause difficulties on opening, particularly with small volumes of high specific activity material.
- 8.6 Check for possible breakages or cracks in the vial. Perform wipe tests as necessary.
- 8.7 Record nuclide, chemical composition, activity and date of receipt in register. Ensure container is properly labeled.

8.8 If material is not to be used immediately, place in safety container and store in a shielded safe or refrigerator as appropriate.

8.9 In the event of any untoward event or contamination problem call the RPO immediately (Tel. 2859 2547).

## 9. Radioactive Waste

9.1 Different nuclides and different categories of waste should be segregated at the time of disposal by the individual DRW/DRU. Labelled containers are normally provided in accordance with individual requirements.

## 10. Working Rules

Each department is generally required to prepare its own set of laboratory rules and guidelines which must be in compliance with this document.

## 11. Laboratory Practices (to minimize radiation hazards)

### 11.1 Initial Design of Experiment

11.1.1 All operations should be planned to limit the spread or dispersal of radioactive material. To this end all unnecessary movement of persons or materials should be avoided.

11.1.2 Planning should allow adequate time for the operations required.

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- 11.1.3 The use of new techniques should first be tried out with inactive materials or with material of low activity before being put into operation.
- 11.1.4 Areas in which radioactive work is carried out should be designated, marked and monitored. At the boundaries of such areas, monitoring and control measures should be set up if so required by the radiation levels present.
- 11.1.5 Equipment, glassware, tools and cleaning equipment for use in any particular active area should not be used for work in inactive areas and should be suitably marked. Special consideration should be given to avoiding contamination of major items of equipment which might need to be transferred for economic reasons.
- 11.1.6 When a choice between several isotopes of varying toxicities is possible, one of relatively low toxicity should be used.
- 11.1.7 Materials of low specific activity should be used if possible.
- 11.1.8 The quantity of radioactive substances chosen as necessary for a specific purpose should always be as small as possible.
- 11.1.9 The working methods should be studied and procedures adopted to avoid as far as possible the dispersal of radioactive material, in particular through the formation of aerosols, gases, vapours or dusts.

## 11.2 Working Procedures (General)

Laboratory rules must be observed absolutely and these will normally include an appropriate selection from the following:

11.2.1 The following should not be permitted in working places containing unsealed sources:

- Food or beverages.
- Smoking items or snuff tobacco.
- Handbags.
- Lipsticks and other cosmetics, or items used to apply them.
- Utensils for eating or drinking.

11.2.2 Hands should be washed thoroughly before leaving the CRA (special attention should be given to the nails, in between fingers and outer edges of the hands).

11.2.3 Monitoring of hands, shoes and street clothing, if worn at work, may also be necessary before leaving the CRA.

11.2.4 No sealed or unsealed radioactive sources should be manipulated with the hands.

11.2.5 All radioactive sources should be handled with equipment and facilities providing protection against external radiation to comply with the following limits:

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- inside controlled areas: less than 0.01 mSv/h
  - inside supervised areas: less than 0.003 mSv/h
  - in general public areas: less than 0.001 mSv/h
- 11.2.6 Manipulations should be carried out over a suitable drip tray, or with some form of double container which will minimize the importance of breakages or spills. It is also useful to cover the working surfaces with absorbent material to soak up minor spills. The absorbent material should be changed when unsuitable for further work and be treated as radioactive waste. The handling tools and equipment used should be placed in nonporous trays with absorbent disposable paper, which should be changed frequently. Pipettes, stirring rods and similar equipment should never be placed directly on the bench or table. After use, all vessels and tools should be set aside for special attention when cleaning.
- 11.2.7 No solution should be pipetted by mouth in any isotope laboratory.
- 11.2.8 Anyone who has an open skin wound below the wrist (protected by a bandage or not) should not work with radioactive isotopes without medical approval.
- 11.2.9 The use of containers or glassware with cutting edges should be avoided.
- 11.2.10 Glass-blowing by mouth should be avoided in places where unsealed radioactive substances are utilized.
- 11.2.11 Only self-adhesive labels should be used in CRAs. Labels that must be wetted should be avoided.
- 11.2.12 Protective clothing appropriate to the radioactive contamination risks should be worn by every person in the CRA, even if only very small quantities of radioactive materials are manipulated.
- 11.2.13 Rubber gloves should be worn when working with unsealed radioactive substances. Rubber gloves are provided to protect against contamination of the skin and are of no value for protection from penetrating radiation.
- 11.2.14 Care should be taken to avoid needless contamination of objects by handling them with protective gloves, in particular light switches, taps and door knobs. The gloves should be either taken off or a piece of non-contaminated material (paper), which should be disposed of afterwards with the contaminated residue, should be interposed.
- 11.2.15 Contaminated gloves should be washed before taking them off.
- 11.2.16 A method of putting on and removing rubber gloves without contaminating the inside of the gloves should be used. This procedure is such that the inside of the glove is not touched by the outside, nor is any part of the outside allowed to come in contact with the bare skin. It is desirable to use gloves whose the inside and outside are distinguishable.

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11.2.17 Radioactive contamination of the air of the working places should be reduced as much as possible. All operations likely to produce radioactive contamination of the air through the production of aerosols (in particular the heating of radioactive solutions), smoke or vapours should be done in an air-tight enclosure kept below atmospheric pressure (glove box) or in a fume hood.

11.2.18 Wet operations should be used in preference to dry ones.

11.2.19 Frequent transfers should be avoided.

11.2.20 Clean up spills immediately to prevent contamination of the atmosphere through dusting.

***For work with animals one must also pay attention to:***

11.2.21 Excreta and body constituents from biopsies and autopsies and animal cadavers should be treated as radioactive wastes. Possible hazards of spread of contamination through the decomposition process should be prevented, e.g. by deep freezing and the use of disinfectants and sealed plastic containers.

11.2.22 Special provisions for the collection of excreta and decontamination of cages should be made.

11.2.23 The radioactive animals or their cages should be marked with labels indicating the nature and amount of radioisotopes used and the time of administration.

11.2.24 No uncontrolled exchange of animals, instruments or cages between active and inactive laboratories should be allowed.

11.2.25 Precautions should be taken to prevent the possibility of contaminated wounds in the course of handling the animals and of contamination from radioactive aerosols or splashings produced by the animal's movements or by coughing.

11.2.26 The presence of vermin as potential vectors of contamination should be considered.

### **11.3 Storage**

11.3.1 All radioactive sources must be clearly labelled giving information on activity, date and chemical form.

11.3.2 The place of storage should be adequately shielded.

11.3.3 Only authorized personnel should be allowed to introduce or remove sources into or from the place of storage, which should be secure against tampering.

11.3.4 The place of storage should be chosen so as to minimize risk from fire.

11.3.5 The places where sources are stored should be inspected regularly and checked for possible contamination.

11.3.6 When either sealed or unsealed sources are liable to release a radioactive gas, their place of storage should be efficiently vented to the open air by mechanical means before it is opened.

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- 11.3.7 Records should be kept of all stored radioactive sources.
- 11.3.8 Bottles containing radioactive liquids should be placed in vessels large enough to hold the entire contents of the bottles in case of breakage.
- 11.3.9 Special precautions are required when opening vessels containing radioactive liquids liable to catch fire, explode or froth.

#### 11.4 Rubber Glove procedure

The technique employed in the procedure is such that the inside of the glove is not touched by the outside, nor is any part of the outside allowed to come into contact with the bare skin. The procedure is as follows :

- 11.4.1 The gloves should be dusted internally with talcum powder.
- 11.4.2 The cuff of each glove should be folded over, outwards, for about 5 cm.
- 11.4.3 Put one glove on by grasping only the internal folded-back part with the other hand.
- 11.4.4 Put the second glove on by holding it with the fingers of the gloved hand tucked in the fold and only touching the outside of the glove.
- 11.4.5 Unfold the gloves by manipulating the fingers inside the fold.
- 11.4.6 In taking off the gloves, seize the fingers of one glove by the other gloved hand and pull free.

- 11.4.7 Take off the other glove by manipulating the fingers of the free hand under the cuff of the glove and fold it back so that an internal part is exposed which may be seized, and the remaining hand freed.

It is a great advantage if the inside and the outside of the gloves can be readily distinguished, e.g. by colour or texture.

#### 11.5 Transportation within Establishment

- 11.5.1 No more radioactive material should be moved than is required.
- 11.5.2 Radioactive materials should be transported in adequately shielded and closed containers. The containers should be so constructed as to prevent accidental release of the source material in case of upset.
- 11.5.3 The transport container should be clearly marked with warning signs, such as:
- Nature of contents
  - Physical condition
  - Activity in becquerel units (e.g. Bq, kBq, MBq)
- 11.5.4 Any loss of radioactive materials during transport should at once be reported to the RPO.
- 11.5.5 Suitably trained workers should be in charge of all transportation of hazardous quantities of radioactive material inside an establishment.

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## 11.6 Accidents

Any unplanned happening which may introduce a radiation hazard is considered to be an ACCIDENT or an EMERGENCY. Such happenings may arise from a wide variety of causes ranging from a simple spill of radioactive material to a natural disaster such as flood or earthquake.

11.6.1 Priority must be given to human safety according to need and urgency.

11.6.2 A serious fire hazard must take precedence over a contamination hazard.

11.6.3 Warn all other persons in the vicinity by the most appropriate means. Inform the DRSR or the RPO as soon as possible.

11.6.4 In the case of a spill of radioactive material, without other complications, primary consideration must be given to containment of contamination. The extent of contamination should be determined and the area clearly marked.

11.6.5 Persons directly contaminated by a wet spill should immediately remove clothing affected and thoroughly wash the hands and other contaminated areas of the body.

11.6.6 If an inhalation hazard exists, all persons not involved in carrying out planned safety procedures should vacate the contaminated area immediately.

11.6.7 If evacuation of the room is required, it will generally be desirable to shut off all mechanical ventilation and to close all outside openings. However, there may be local conditions which require

consideration. For example, if the release occurs in or near a fume hood, it may be disadvantageous to take any action which would discontinue ventilation by the hood.

11.6.8 Except in case of injury or other urgent need, persons who have vacated the contaminated area should not leave the immediate vicinity until they have been monitored and necessary precautions, such as the removal of shoes or outer clothing, have been taken to limit further spread of radioactivity.

11.6.9 Re-entry into the affected area must be restricted to properly equipped persons until the area is declared safe by the DRSR or the RPO.

11.6.10 All accidents should be fully reported. This report may have an important bearing on staff health and legal responsibilities and may assist the RPO in making a detailed study with a view to avoiding similar accidents in the future.

11.6.11 All accidents should be investigated and appropriate measures should be taken to prevent repetition of the accident.

## 11.7 Decontamination Procedures (Personnel)

11.7.1 Decontamination of the eyes should be undertaken immediately. Not only the radioactive isotope is to be considered, but also the chemical nature of the contaminant and possible complications due to foreign bodies and mechanical or chemical irritants. Additional irritation of the eyes by decontamination procedures

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should be avoided. Immediate irrigation of the eyes with a copious amount of water or with appropriate medically approved solutions is recommended.

11.7.2 Care should be taken to avoid as far as possible the spread of the contamination to uncontaminated parts of the body and to avoid internal contamination. If there is a risk of such a spread, an attempt should first be made to remove the contamination locally with absorbent material, and if necessary, with a proper masking of the adjacent non-contaminated areas of the skin. A non-contaminated open wound should be protected.

11.7.3 The immediate washing of contaminated areas with water and soap is the method of choice for removing loose contamination, subject to certain elementary precautions:

- Tepid water should be used.
- Soap should not be abrasive or highly alkaline.
- The washing can be helped by scrubbing with a soft brush only in such a way as not to abrade the skin.
- The skin should be washed for a few minutes at a time, then dried and monitored.
- Washing can be repeated if necessary (as indicated by monitoring) provided that there is no indication of damage to the skin.

11.7.4 If this procedure fails, only a mild detergent approved by the RPO might be used, although repeated applications of

detergents to the same area of the skin, hands for instance, might injure the skin and make it penetrable.

11.7.5 Special attention should be paid to proper decontamination of creases, folds, hair and such parts of the hands as finger nails, inter-finger space and the outer edges of the hands.

11.7.6 The use of organic solvents or of acid or alkaline solutions should be avoided.

11.7.7 After each decontamination operation, the treated place should be dried with a fresh non-contaminated towel or swab and monitored. All towels and swabs used in the decontamination process should be treated as contaminated material.

11.7.8 While decontaminating the face, special care should be taken not to contaminate the eyes or lips.

11.7.9 Attempts to remove contamination which resists washing should only be made under medical supervision.

## 11.8 Decontamination Procedures (Equipment and Surfaces)

11.8.1 A decision to decontaminate material must take into account the continuing value of the material compared with the cost of decontamination.

11.8.2 Where the half-life of the contaminating element is short, it may be desirable to store tools and glassware for decay of activity rather than to attempt decontamination.

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- 11.8.3 Decontamination of equipment should generally be done as soon as possible after its use. In many cases this will prevent the contamination from getting fixed and from being ultimately more difficult to deal with. It will often be found that surfaces that have been kept moist are easier to clean.
- 11.8.4 The cleaning of contaminated glassware and tools should be done with great care by informed persons in a well ventilated hood set aside in the laboratory for that purpose, or in special decontamination areas.
- 11.8.5 The uptake of radioactive substances by glassware may be reduced by a preliminary treatment with the corresponding inactive chemical.
- 11.8.6 In some cases immersion in solutions of the non-radioactive isotope of the contaminant may be tried, although this is a slow procedure.
- 11.8.7 The solutions used for cleaning should not be returned to the stock bottles between uses.
- 11.8.8 Laboratory equipment should be surveyed for residual contamination following decontamination procedures. If the residual contamination indicates that the level of activity remains greater than that specified as permissible, the equipment should not be re-used and should be regarded as radioactive waste.
- 11.8.9 Spilt liquid should be absorbed on paper tissue or "Vermiculite". Always work in towards the centre of contamination and take care not to "track" the contamination. Surfaces should be cleaned by wet methods where possible (dry methods may create a dust hazard). Do not use sluicing methods which may spread contamination.
- 11.8.10 Self adhesive tapes or strippable paint may be used on non-porous surfaces for removal of loose dry contamination.
- 11.8.11 Contaminated clothing and linen should not be released to public laundries without the approval of the RPO.
- 11.8.12 If the clothing or linen cannot be decontaminated to a safe level it should be regarded as radioactive waste.

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## 11.9 Useful Decontamination Agents

Type of surface or equipment	Decontamination agent	Treatment
Walls, floors etc. Contaminated clothing	Suitable detergents or wetting agents (Simple detergents are not satisfactory and it is preferable to add a little E.D.T.A.)	A first method for particularly greasy or dirty surfaces. Use a 0.5% solution with swabbing or scrubbing action or in a washing machine for clothing.
Textiles Plastics Paints Rubber Metals	Complexing solutions (Combinations of citric acid, E.D.T.A., etc.) "Decon"	Use in the form of a cream or immerse articles in tanks for periods up to several hours. (0.8% solution at elevated temperatures.)
Linoleum	Organic solvents	To remove the normal waxed coating carrying off the contamination.
Machine tools	Solvents (Proprietary grease or emulsifying solvents)	Apply directly to heavily oiled and greasy surfaces with a cloth or brush. Emulsifying solvents may be rinsed off with water.
Glassware	Nitric acid; ammonium citrate; chromic acid	Use in the normal way.
Stainless Steel	Sulphuric acid	These dissolve the contaminated surface taking it into solution.
Mild steel and light alloys	Sulphuric acid with inhibitors	
Ferrous metals	Nitric acid /Sodium fluoride Proprietary rust removers	
Painted surface	Paint removers Solvent strippers Alkaline strippers	Use in difficult cases where the paint itself has to be removed

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