Prevention of experiment-related accidents, etc.

During experiments or practice, please attempt to prevent accidents according to the instructions from the faculty and staff.

The following accidents have occurred in the past.

No.	Accident example	Overview
1	Solution entered eyes because of not wearing protective glasses during experiment.	During the process of transferring solution from test tube to glass cell for measurements, a drop that spilled into another beaker of the solution below bounced and got into the eyes of the student. The student was not wearing protective glasses.
2	Explosion of experimental equipment	When a combustible and combustion-supporting gas were mixed and discharged for an experiment to produce fine particles, an explosion occurred inside the device and the acrylic plate lid was blown to pieces. There were no physical injuries due to the explosion, but the student collapsed due to anemia when cleaning up after the accident. The student was injured by hitting the corner of the laboratory table and cutting the forehead.
3	Cutting fingertip with machine tool	While cutting a large metal plate using a foot-pedal-based cutting machine, the pedal unexpectedly touched the footrest, the blade descended, and an injury occurred—the tips of the middle and ring fingerers of the left hand were cut.
4	Gas leak from gas cylinder	After completing an experiment using high-pressure gas, the main valve of the gas cylinder was not closed, and the regulator was malfunctioning (when the secondary valve is closed with the main valve open, the gauge indicating the secondary pressure rises and the safety valve opens), so the gas leaked and a foul odor was generated in the laboratory and surrounding rooms. No human damage was reported.
5	Ignition from wiring cord	During electrical and instrumentation work, the cords that were connected to the voltage measuring instrument were bundled and used. This generated heat, melted the coating the device, and resulted in ignition (presumed). No human damage was reported.
6	Accident due to upper plate of experimental device	The student forgot that the upper plate of the experimental device was hung by a crane, and their head hit the plate causing an injury in the right eyebrow.
7	Accident during gas filling	During gas filling, the glass bottle burst, pieces of glass splattered, and approximately 2 cm of the student's left ring finger was cut.
8	Slipping and falling	When coming to pick up experimental materials, the student slipped and fell, tearing their chin on the partition block of the material storage area.
9	Broken glass trap	While removing the pressure-resistant rubber tube on the trap inlet side, the liquid inside was suddenly pushed out to the outlet by atmospheric pressure. The force broke the glass trap and caused a shallow cut with a length of approximately 15 cm from the scattered glass pieces.
10	Cuts caused by cutter grindstone fragments	When cutting a round iron rod with a fine cutter, the rotating grindstone was damaged and scattered debris, one of which hit the student's head near the right eye and caused a cut of approximately 2 cm.

No.	Accident example	Overview
11	Acetone ignition due to overheating of hot plate	A powder obtained by mixing titanium powder, hydroxyapatite powder, and a small amount of acetone was put into a metal plate and heated on a hot plate, whereupon the acetone ignited and generated a fire.
12	Rupture of glass chemical bottle during etching process	When the waste liquid of an etching solution that was separately prepared with different concentrations of nitric acid and hydrochloric acid was mixed in a glass bottle and its lid was closed, the bottle burst and scattered, damaging the front glass of the fume hood.
13	Getting caught between sample and fixed vise.	When attempting to fix a semi-cylindrical metal material to the base of a band saw cutting machine with a vise to cut it, the left thumb holding the material was placed between the vise and material was caught.
14	Chemical burns caused by concentrated sulfuric acid	A beaker, which contained a strongly oxidizing solution, slipped out of the hands of a student and broke, and the solution spilled on the student's limbs.
15	Fire caused by forgetting to turn off power supply	The heater in the plastic bucket was overheated, the water in the bucket evaporated and became "empty," the heat of the heater ignited the plastic, and the fire spreading to a part of the laboratory.
16	Ignition of organic solvent during experiment	Organic solvent was ignited during an experiment that involved the application of a pulsed laser to an organic solvent in which fine particles were dispersed. In a haste to deal with it with bare hands, the student suffered burns on both hands.
17	Fire due to malfunction of drying furnace	When the drying furnace was operated to remove rust from the reinforcing bars, the temperature-limiting device malfunctioned due to the deterioration of the drying furnace, so the temperature continued to rise and a fire broke out. The tools, electric wires, measuring appliances, etc., on the drying furnace were burned as a result.
18	Puncture injury	During an organic synthesis experiment, the right hand, which was holding an injection needle while trying to conduct delicate work, quivered and the needle stabbed the student's left wrist.
19	Small fire in laboratory	When cleaning an asphalt container, the flame of the stove ignited the waste cloth, and the flame of the ignited waste cloth spread to another waste cloth that was wet with a small amount of kerosene nearby.
20	Fire in chemical heat storage experimental device during experiment	During the heating of oil by a throw-in-type electric heater as part of preliminary preparation for an experiment using a chemical heat storage experimental device, a fire broke out from the oil in the container.
21	Accident in which the thumb was caught between a universal testing machine and a test jig	In the attempt to attach a test jig to the universal testing machine, the portion up to the first joint of the right thumb, which was supporting the test jig, got caught between the jig and the universal testing machine and led to a tear injury of the fingertip.
22	Ignition accident during a heating experiment with cutting oil	When an oil mist evaluation device was used to conduct a capture experiment using cutting oil with a filter, the oil became ignited. No human damage was reported.
23	Hand injury due to breakage of quartz tube while encasing a metal sample in the quartz tube	While attaching the quartz tube to the hose, more force than necessary was applied leading to breakage of the quartz tube and causing a deep cut injury from the base of the left thumb to the base of the index finger.

No.	Accident example	Overview
24	Fire on a weekend night	Fire broke out on and around the lightweight workbench. No human damage was reported.
25	Fire due to mismanagement of experimental waste	When samples that were heated in experiments were discarded without following protocol, the dust in the trash can ignited. No human damage was reported.
26	Contusion wounds of the fingers of left hand while dividing plate-shaped asphalt concrete debris by strike	While smashing the plate-shaped asphalt concrete debris onto the floor outdoors, fingers were caught between the debris and the floor, resulting in contusion wounds.
27	Ignition of tubular electric furnace rubber stopper	While the tubular electric furnace was operating at 1000°C, silicone rubber stoppers at both ends of the mullite tube, which had Ar gas flowing through it, were heated and ignited.

Accident example 1	**Solution entered eyes because of not wearing protective glasses during experiment.**
Overview	**During the process of transferring solution from test tube to glass cell for measurements, a drop that spilled into another beaker of the solution below bounced and got into the eyes of the student. The student was not wearing protective glasses.**

1. When

During a student experiment (weekday, around 4:40 p.m.)

2. Where

General chemistry laboratory

3. What kind of accident

At around 4:40 p.m., a first-year undergraduate student was conducting a chemical experiment (experiment theme: colorimetry), in which a mixed solution (cuprammonium solution) composed of an aqueous copper sulfate solution (concentration: 4×10^{-2} mol/L) and ammonia water (8 mol/L), was transferred from the test tube to the measuring glass cell for absorbance measurements. During the transfer, **the solution spilled** and entered the beaker with the cuprammonium solution that was underneath the glass cell. At that time, the cuprammonium solution in the beaker **bounced back and entered the left eye of the student.**

4. How was this handled

The student **immediately washed their eyes with a large amount of water**, and the instructor continued to wash the student's eye with distilled water using a washing bottle for 15 minutes before heading to the hospital.

At around 5:00 p.m., the staff was asked to accompany the student to the hospital, and **water and towels were prepared when the student was sent to the hospital so that they could continue to wash their eyes on the way from university to the hospital.**

At around 6:15 p.m., the physician prescribed eye treatment, eye drops, and oral medicine at the hospital, and the student returned to the university with the staff member.

5. Cause of accident

In the chemistry experiment class for the first-year undergraduates, prior to each experiment, students are instructed to always wear protective glasses as a safety measure during experimentation. Even when going around to observe students during the experiment, instructors always give a warning to students who are not wearing their glasses. **Only the student involved in the accident was not wearing protective glasses**, and they were warned several times. When asking the individual after the accident, the student stated that they were not wearing protective glasses during the accident. This was the main cause of this accident.

On this day, the student had made mistakes in the operation, and they were warned each time. It appeared that the student had not slept enough in preparation for the test, and thus, the student's concentration might have decreased. This might have contributed to the accident.

6. How to prevent this

This is the first accident of its kind in the first-year undergraduate chemistry experiment since the founding of the university. Hence, the accident could not be attributed to the experiment procedure, and **the accident could have been prevented if the student had worn their protective glasses**.

What are protective glasses?

(Note: this is not a photograph of the accident)

Accident example 2	**Explosion of experimental equipment**
Overview	**When a combustible and combustion-supporting gas were mixed and discharged for an experiment to produce fine particles, an explosion occurred inside the device and the acrylic plate lid was blown to pieces.** **There were no physical injuries due to the explosion, but the student collapsed due to anemia when cleaning up after the accident. The student was injured by hitting the corner of the laboratory table and cutting the forehead.**

1. When

During research experiment by graduate student (weekday, around 11:00 a.m.)

2. Where

On-campus joint education and research facility laboratory

3. What kind of accident

During research on the production of ultrafine oxide particles using a fine wire discharge device to control the particle size and structure of nanoparticles that were generated by changing the thermal conductivity of the gas, a graduate student **mixed ammonia and oxygen gas,** and **discharged** it at a total pressure of 0.5 atm. An **explosion** occurred as a result, the acrylic plate that was used as a lid for the device was damaged and scattered, and the fluorescent tube and hand mirror were crushed.

A staff member arrived approximately 20 seconds later, and saw a graduate student walking out of the room. Upon receiving a report from the student about the explosion, it was confirmed that the graduate student was not injured at this point. While conducting **post-treatment, such as gas closure and cutting off power supply**, the graduate student fell to the floor due to **anemia**, resulting in **lacerations and bleeding** as they hit their face against the corner of the experimental device.

4. How was this handled

The staff member **called 119 and the Research Promotion Division** to provide **treatment at the hospital**. An intravenous drip was given due to hypotension, and the laceration was sutured. Blood test results were normal, so the student returned home at 5:00 p.m. the same day.

5. Cause of accident

Because the graduate student **did not recognize that ammonia was a flammable gas and discharged it after mixing it with oxygen, this resulted in an explosion**, and the device was damaged.

6. How to prevent this

(1) Safety education: Conduct safety education. Until now, only lectures were given, so a **test**

that confirmed proficiency was conducted.

(2) Posting: Instructions on **hazards, flammable chemicals, gases, and their combinations** were posted in the laboratory (Photograph 2).

(3) Experiment plan: **Consult with an instructor when starting an experiment using new chemicals or gas.**

(4) Equipment measures: A rupture disk was installed for two large chambers with a volume of over 20 L out of the three devices as a safety valve for releasing internal pressure in a safe direction even in the event of an explosion.

The acrylic flange was replaced with a metal flange that is not prone to brittle fracture.

The gas type was described on the pipe to avoid accidents (Photograph 3).

An acrylic cover was used to prevent an electric shock accident at the exposed part of the wiring.

A red lamp that lights up during charging serves was installed as a warning indicator to prevent electric shocks during charging and discharging. Additionally, a switch that is manually connected between the gap switches was abolished, and an electrically driven remote-controlled discharge switch was installed (Photograph 4).

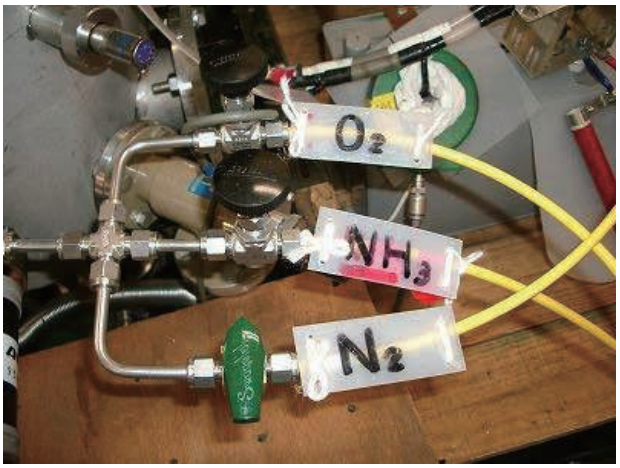
(5) Risk assessment: **A risk assessment was conducted. Risk predictions and countermeasures** were also conducted as part of the guidelines.

(6) Experimental procedure manual: **An experimental procedure manual (equipment manual) was prepared.**

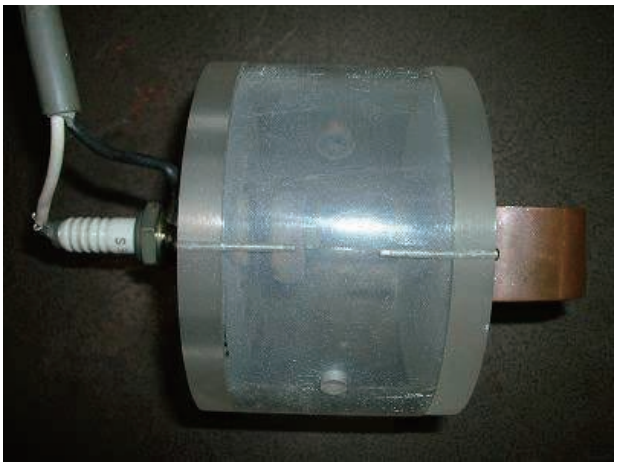
Photograph 1 Device where accident occurred

Photograph 2 Posting of hazards, flammable chemicals, gases, and their combinations

Photograph 3 Display of gas type on pipe



Photograph 4 Remote control discharge switch



Accident example 3	**Cutting fingertip with machine tool**
Overview	**While cutting a large metal plate using a foot-pedal-based cutting machine, the pedal unexpectedly touched the footrest, the blade descended, and an injury occurred—the tips of the middle and ring fingerers of the left hand were cut.**

1. When

During experimental copper plate processing (weekday, around 2:00 p.m.)

2. Where

Shared-use workshop

3. What kind of accident

A graduate student **cut their fingertips while processing** a copper plate (thickness 1 mm) **by themselves with a foot-pedal-based cutting machine**.

(The student described the incident from the ambulance and after surgery, they said that the blade went down when it was set and their foot touched the foot pedal, but the student was agitated and did not remember the situation well.)

4. How was this handled

The graduate student in question quickly brought their amputated fingers to a nearby laboratory and asked for help.

Two students in an adjacent laboratory were the main responders. **First, 119 was called**. Under the guidance of an instructor in the front room, **the bleeding was stopped; the hand and amputated fingers were waterproofed in a plastic bag, and stored in a bucket that was filled with ice water**. The academic supervisor was also contacted by phone. The academic supervisor contacted the director and headed to the site together. Afterwards, **the Physical Education and Health Center was contacted, a physician and public health nurse rushed over, and treated the student**. The Student Support Division was contacted, and the student's guardian was contacted.

The student arrived at the hospital by ambulance at around 3:00 p.m. Treatment was started immediately, and an inspection and radiography were conducted. The surgery was started at 4:30 p.m. and ended at around 6:30 p.m.

5. Cause of accident

A foot-pedal-based cutting machine for cutting large metal plates was used to cut samples that measured several square centimeters.

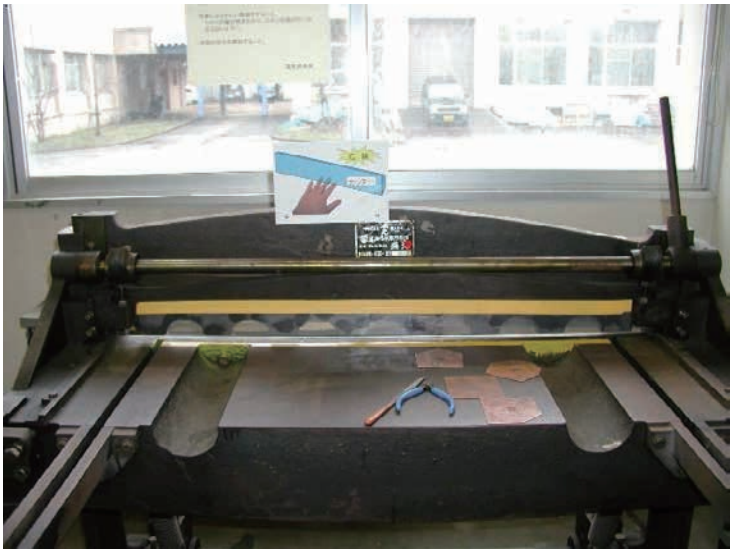
6. How to prevent this

(1) **Investigate a construction method that suits the sample and minimizes risk.**

(2) In addition to giving education on machine tools in safety education at the time of guidance for student experiments, give specific explanations and alerts to the accident examples that have occurred on campus.
(3) Post a “Precautions for using the foot-pedal-based cutting machine” in front of the machine.
(4) Impose strict adherence to the usage time of the shared-use workshop. The workshop is to be used by two people or more at a time for emergency response.
(5) Modify the device so that fingertips cannot enter the space where the sample is placed in the foot-pedal-based cutting machine.

Foot-pedal-based cutting machine (before improvement)

Foot-pedal-based cutting machine (after improvement)



Accident example 4	Gas leak from gas cylinder
Overview	After completing an experiment using high-pressure gas, the main valve of the gas cylinder was not closed, and the regulator was malfunctioning (when the secondary valve is closed with the main valve open, the gauge indicating the secondary pressure rises and the safety valve opens), so the gas leaked and a foul odor was generated in the laboratory and surrounding rooms. No human damage was reported.

Photograph 1
Problematic regulator

1. When

After research experiment (weekday, around 1:00 p.m.)

2. Where

On-campus joint education and research facility laboratory

3. What kind of accident

Ammonia (NH_3) leaked around the installed experimental equipment, generating a **foul odor** in the laboratory and nearby laboratories.

4. How was this handled

The main valve of the gas cylinder was closed, and the room was ventilated.

5. Cause of accident

An experiment using NH_3 was conducted two days ago. **After the experiment, the main valve of the NH_3 cylinder was not sealed (there was no rule to close it).** An investigation after the accident revealed that the cylinder regulator had a problem where the gauge that shows the secondary pressure increased when the secondary valve was closed without closing the main valve of the cylinder. It is thought that after the end of the experiment, the secondary pressure was gradually increased, and at around 1:00 p.m., approximately 45 hours after the experiment, the safety valve of the regulator was opened, and all the gas leaked out at once.

Photograph 2
New cylinder cabinet

6. How to prevent this

(1) **Re-create the experimental work manual, and ensure sealing the main valve of the cylinder and to turn on the exhaust switch of the cylinder cabinet.**

(2) Dispose the problematic regulator and use a new one.

(3) Use a cylinder cabinet.

The inside of the cylinder cabinet of Fig. 2 is exhausted by turning on the exhaust switch and discharging the gas to outside. In the future, this cylinder cabinet is to be used,

and gas diffusion indoors is prevented even in the event of a gas leak.

(4) The regulator that was used for NH_3 must be used with NH_3-compliant products. Because there are potential problems such as due to corrosion, replace this with a space regulator that incorporates new internal parts approximately once a year.

Accident example 5	**Ignition from wiring cord**
Overview	**During electrical and instrumentation work, the cords that were connected to the voltage measuring instrument were bundled and used. This generated heat, melted the coating the device, and resulted in ignition (presumed). No human damage was reported.**

1. When

During electrical and instrumentation work (weekday, around 6:00 p.m.)

2. Where

Environment building laboratory

3. What kind of accident

During the electrical and instrumentation work on the laboratory table, a fire suddenly broke out from the power cable of the voltage measuring instrument (Asahi Keiki) that was placed on the laboratory table.

4. How was this handled

Fire-extinguishing activities were conducted to extinguish the fire on the laboratory table using the powder fire extinguisher that was installed in the laboratory immediately after the accident, and the fire was extinguished within one minute.

5. Cause of accident

Heat was generated by bundling and using the long cords that were connected to the voltage measuring instrument, which melted the coating and ignited the material.

6. How to prevent this

(1) When conducting electrical and instrumentation work for the first time, do it in the presence of technical staff or instructors.

(2) When connecting the power cable, ensure that it is used according to the conditions and recommendations by the manufacturer.

(3) When conducting electrical and instrumentation work, move peripheral equipment to another location as far as possible.

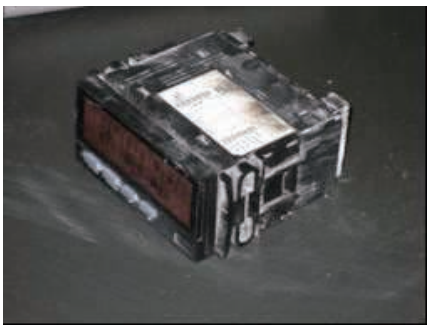
(4) Conduct electrical and instrumentation work with at least two people.

(5) The power cable should have an appropriate length that matches the distance between the outlet and installation location of the experimental equipment.

(6) Do not leave the laboratory absent during the experiments.

Site of occurrence (left side: experimental table)

Burnt electrical wiring



Partially burnt voltage indicator

Accident example 6	**Accident due to upper plate of experimental device**
Overview	**The student forgot that the upper plate of the experimental device was hung by a crane, and their head hit the plate causing an injury in the right eyebrow.**

1. When

During post-processing of experiment (weekday, around 11:00 a.m.)

2. Where

Large-scale construction experiment building

3. What kind of accident

The student forgot that the upper plate of the experimental device was hung by a crane. As they did not lift it by hand, **they hit the area around their right eyebrow and cut it** while working.

4. How was this handled

The senior colleague that was working together with the student immediately prepared tissues, and the student strongly pressed the tissues on the affected area to **stop the bleeding,** went to the Physical Education and Health Center for first aid, after which they received medical treatment at the Nagaoka Nishi Hospital.

5. Cause of accident

It is thought that the student was **distracted** because of the interest in the experiment.

6. How to prevent this

Do not neglect your attention to surroundings, and work while prioritizing safety.

Accident example 7	**Accident during gas filling**
Overview	**During gas filling, the glass bottle burst, pieces of glass splattered, and approximately 2 cm of the student's left ring finger was cut.**

1. When

During research experiment by a graduate student (weekday, around 6:00 p.m.)

2. Where

Environmental reaction engineering laboratory on 4th floor of environmental building

3. What kind of accident

A glass bottle with a capacity of 5 L was **filled with nitrogen gas** for reagent preparation. The glass bottle had a gas inlet and outlet to control the pressure inside the glass bottle. However, the **glass bottle burst** during gas filling, and the glass pieces scattered. As a result, approximately 2 cm of the student's left ring finger was wounded.

4. How was this handled

The student immediately closed the gas cylinder, asked other students in the laboratory to clean up the mess, immediately went to the Nagaoka Red Cross Hospital to treat the wound, and had four stitches sewn in.

5. Cause of accident

The accident was caused by the strong **gas pressure in the glass bottle**.

6. How to prevent this

It is important to properly **check the pressure** when using the gas cylinder, and **ensure a sufficient gas inlet/outlet for gas** to prevent the accident in the future.

Accident example 8	**Slipping and falling**
Overview	**When coming to pick up experimental materials, the student slipped and fell, tearing their chin on the partition block of the material storage area.**

1. When

During construction engineering lecture (weekday, around 4:00 p.m.)

2. Where

Concrete laboratory, first floor of machinery construction building No. 3

3. What kind of accident

A fourth-year student of the concrete laboratory was working on a concrete canoe as part of an assignment on the subject "Construction engineering lecture" for the fourth-year construction engineering course that is given in the first semester. On this day, the canoe was developed during the "Construction engineering theme seminar I" for the second-year students of the construction engineering course. The second-year students were touring at the production site and the fourth-year students were explaining the canoe in the presence of the instructor in charge. A student headed to the material storage area in the courtyard to fetch the aggregate for concrete, but **slipped and fell**, and tore their chin on the partition block of the material storage area.

4. How was this handled

Immediately after falling, the student reported to the instructor in charge that they fell and injured themselves, and the student went to the Health Office unaccompanied. Afterwards, a fourth-year student came over to see the injured student's status. The injured student returned after getting treated with a bandage. In the Health Office, the student was instructed to wait after this treatment. Thus, it was decided that the student should consult a medical institution as soon as possible just in case, and after consulting with the Machinery Construction Office, the student was taken to the Imura Orthopedic Surgical Clinic (Ojimahoncho, Nagaoka City) by the instructor in charge. The physician's judgment was that there was no need for stitches. The student was treated using antibiotic ointment, and was instructed to visit the hospital the next day.

5. Cause of accident

This accident did not involve any particularly dangerous work or any neglect in attention, but **serious incidents can occur because of even a fall** in the laboratory and material storage area.

6. How to prevent this

Pay close attention to your feet, and give thorough guidance so that you can walk on solid ground without rushing.

Accident example 9	**Broken glass trap**
Overview	**While removing the pressure-resistant rubber tube on the trap inlet side, the liquid inside was suddenly pushed out to the outlet by atmospheric pressure. The force broke the glass trap and caused a shallow cut with a length of approximately 15 cm from the scattered glass pieces.**

1. When

During experiment in laboratory (weekday, around 11:00 a.m.)

2. Where

Materials Systems Building No. 2, 3rd floor

3. What kind of accident

Methanol, which is a solvent, was **distilled off under decompression** from the reaction mixture that was placed in a flask. A trap containing an aqueous solution of sodium hydroxide was sandwiched between the flask and water flow pump to prevent the sulfur dioxide gas that remained in the solution from entering the drainage. When the pressure-resistant rubber tube on the trap inlet side was removed partway, the liquid inside was suddenly pushed out to the side of the outlet by atmospheric pressure, and the **glass trap was damaged** by that momentum. The scattered glass pieces inflicted an approximately 15 cm-length **shallow cut** from the side of the little finger to wrist of the right hand.

4. How was this handled

The **wound was immediately washed** with running water, after which the student went to the Physical Education and Health Center and received treatment. The wound was not very deep, so the student only received disinfection and wound protection treatment, resuming the experiment in the afternoon.

5. Cause of accident

The amount of the aqueous solution in the trap was too large and the pressure-resistant rubber tube was suddenly pulled out when the decompression was released, resulting in a **sudden pressure change**. Furthermore, the damaged trap was discarded and could not be confirmed, but there is also the possibility that the “sealing” at the top was scratched for some reason, reducing the mechanical strength.

6. How to prevent this

Do not put too much liquid in the trap. Furthermore, **when releasing the decompression**, use a T-shaped tube and screw cock to **gradually release it**. In addition, instruct this to the students who are conducting similar experiments.

Accident example 10	**Cuts caused by cutter grindstone fragments**
Overview	**When cutting a round iron rod with a fine cutter, the rotating grindstone was damaged and scattered debris, one of which hit the student's head near the right eye and caused a cut of approximately 2 cm.**

1. When

During experiment in assignment research (weekday, around 4:00 p.m.)

2. Where

Machinery and Construction Building No. 3

3. What kind of accident

A round iron rod with a diameter of 1 cm and length of 1 m was cut with a fine cutter to cut it to a length of 40 cm. By the time the cutting was finished, the rotating **grindstone was damaged and the debris was scattered**. One piece of this debris hit the student near the right eye and inflicted a **cut** of approximately 2 cm.

4. How was this handled

A senior colleague in the next room immediately noticed and provided a Kimwipe (paper waste cloth), and the student headed to the Physical Education and Health Center while obstructing the bleeding. The student then stopped the bleeding and disinfected the wound with gauze, after which the student went to the Red Cross Hospital. An X-ray was taken to see if there were any foreign substances, and since the bleeding had stopped, the wound was healed without stitching.

5. Cause of accident

Instead of fixing the round iron rod at the proper location, the student held it by hand and cut it.

Therefore, the cover that was installed on the device was not lowered.

Therefore, the cause mishandling of the device caused the accident

6. How to prevent this

(1) **Thoroughly cover the device** while operating it, and make this known and post this information.

(2) Instruct the students to **wear protective glasses** as needed.

(3) Provide guidance and encouragement for the maintenance of machinery and equipment and the arrangement of work rooms.

(4) When working alone, talk to the surrounding people.

On-site photographs

Machinery and Construction Building No. 3

	① Fine cutter that caused the accident A disk-shaped grindstone is attached to the rotating shaft and rotated at a high speed to cut the sample. The grindstone is made of ceramics and is fragile. The thickness of the grindstone is approximately 0.5 mm. The iron cover is equipped with an acrylic lid.
	② When an iron cover is placed and the acrylic lid is opened. Rust is present on the bolts of the metal fittings that fix the material. There are no notes around the device that instructs the user to "cover."
	③ When the iron cover and acrylic lid are closed. Used this way when cutting.
	④ When the accident occurred, the work was done by one student, and the cover was lowered. The student was from a technical college and has experience working in the machining center of the university, so the student was familiar with the machine.
	⑤ Acrylic lid Difficult to see inside because of dirt. Also, there is no lighting near the hand placements, making it difficult to understand the work location.
	⑥ Fragments of the grindstone that had broken and scattered were stuck in the ceiling directly above the machine.

Accident example 11	**Acetone ignition due to overheating of hot plate**
Overview	**A powder obtained by mixing titanium powder, hydroxyapatite powder, and a small amount of acetone was put into a metal plate and heated on a hot plate, whereupon the acetone ignited and generated a fire.**

1. When

During experiment in research activities (extra-curricular/weekend, around 2:00 p.m.)

2. Where

Experimental training building No. 2

3. What kind of accident

When a powder mixed with titanium powder, hydroxyapatite powder, and a small amount of acetone was put into a metal plate and heated on a hot plate, the **acetone ignited**, and generated a flame. The accident occurred 10 minutes after the commencement of the experiment. After confirming the absence of abnormalities by observing the circumstances in the first five minutes, the student organized the materials in an adjacent room. Another student visited the laboratory for another purpose, and discovered a small flame.

4. How was this handled

The discoverer first tried to extinguish the fire by covering it with an iron container but was unsuccessful, then the fire was extinguished using a **fire extinguisher** that was installed outdoors.

5. Cause of accident

(Factors during work)

(1) The possibility that acetone would catch fire was recognized. But the student did not expect a problem during the process, and **left the scene**. Therefore, the student was unable to detect the **overheated state** prior to ignition.

(2) The student conducted the experiment without **sufficiently confirming the work procedure and risks** with other people. There is also the possibility that the student hesitated to **contact instructors** because it was a weekend.

(Background factors of the system)

(1) The hot plate was not equipped with an overheating prevention device.

Even though this factor may have contributed to the accident, it is presumed that the factors during the work may had a pivotal effect on the occurrence of the accident.

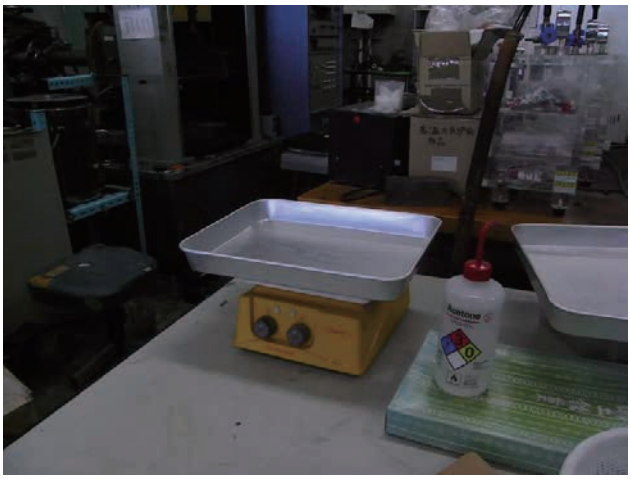
6. How to prevent this

(1) When using acetone during wet mixing, **it should be sufficiently evaporated in a hot water bath** before drying. The experimentalist should be instructed to **monitor whether overheating occurs** until the end of the work.

(2) Students should be reminded that, even when working on weekends, **they should plan proper**

work procedure and consult the instructors prior to the weekend, take measures after the safety evaluation, receive approval, and then conduct the work.

Reference on-site photographs



State of hot plate and surroundings that caused the overheating.
The ignition occurred on the metal plate in the figure.

Hot plate controller.
Only the timer and strength of the device can be controlled.

Accident example 12	**Rupture of glass chemical bottle during etching process**
Overview	**When the waste liquid of an etching solution that was separately prepared with different concentrations of nitric acid and hydrochloric acid was mixed in a glass bottle and its lid was closed, the bottle burst and scattered, damaging the front glass of the fume hood.**

1. When

During experiment in research activities (extra-curricular, weekday, around 2:00 a.m.)

2. Where

Machine construction building No. 2 (Chemical treatment room)

3. What kind of accident

A student was creating an etching solution, by mixing nitric acid and hydrochloric acid, to **etch a stainless steel material**. Separately prepared etching solutions with different concentrations were mixed into a glass bottle and covered with a lid, after which the **bottle burst and scattered**, and the front glass of the fume hood was damaged. Furthermore, the left thumb of the student was injured due to a piece of the scattered glass.

4. How was this handled

The student **provided a verbal notification to a laboratory student** in the adjacent room, and requested a report to the Energy Center through the emergency contact network. After the Energy Center confirmed the accident site, the student, along with other students in the laboratories on the same floor, went to Nagaoka Chuo General Hospital and had a medical examination. Examinations showed that there were no abnormalities other than the **injury on the tip of the left thumb of the student**.

5. Cause of accident

The student was using the etching solutions with different concentrations for the first time, and they did not **sufficiently consider the danger** of developing further reactions by mixing the waste solutions. As a result, when the lid was covered during the reaction, the glass bottle ruptured.

6. How to prevent this

(1) Do not mix waste solutions of etching solutions that were prepared separately into the same glass bottle.

(2) **When mixing chemicals**, **sufficiently check** whether a reaction will occur, and if a reaction occurs, whether the subsequent reaction is stable.

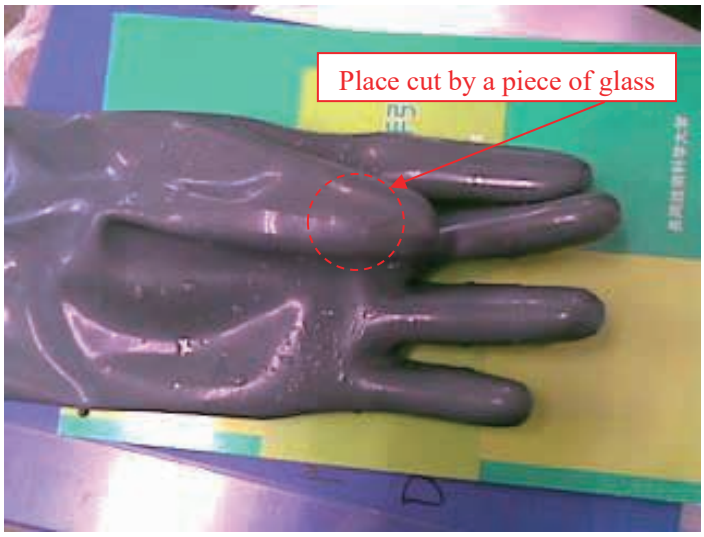
(3) Remind the students to **create plan procedure and consult/confirm with the instructor in advance when working at night**, take measures after safety evaluation, receive approval, and then conduct the work.

(4) The student tried to contact an instructor via the mobile phone, but could not reach them. In the

future, **double-check the contact information** of all associated instructors, including their home phone numbers.

(5) Following the guidance of the academic supervisor, the student wore a lab coat, scarf that doubled as a mask, hat, protective glasses, and acid-resistant gloves, and conducted work in the fume hood. Therefore, there was no damage from the chemicals, but only the fingertips that were injured by the glass pieces. In the future, ensure the same guidance.

(6) After reviewing the work procedure in the laboratory, an **external inspection and evaluation** should be conducted, and a safe procedure will be implemented as needed.



Acid-resistant gloves worn at the time of accident

Student's injury (a cut on the thumb of left hand)
There were no injuries other than the thumb because the student had worn protective glasses, gloves, and a lab coat.

Fume hood after accident
The front glass was damaged because the glass bottle burst inside the fume hood.

Accident example 13	**Getting caught between sample and fixed vise.**
Overview	**When attempting to fix a semi-cylindrical metal material to the base of a band saw cutting machine with a vise to cut it, the left thumb holding the material was placed between the vise and material was caught.**

1. When

During sample processing for experiment (weekday, around 4:30 p.m.)

2. Where

Work center

3. What kind of accident

A student was trying to cut a semi-circular metal material with a diameter of 175 mm and thickness of 55 mm into a size that fits into a melting pot. While using a band saw cutting machine and attempting to fix the material to the table of the machine with a vise, the left thumb holding the material was pinched.

4. How was this handled

Immediately after the accident, the student reported it to the staff of the work center, and the bleeding was stopped. After receiving the report, the staff of the Physical Education and Health Center came and performed first aid with disinfection, gauze, and bandages, after which the student headed to Tachikawa General Hospital at 4:40 p.m.

5. Cause of accident

Normally, when fixing a semi-circular material to the table of a band saw cutting machine, the material is placed on the table with the flat surface of the semi-circle facing down. However, as the material was placed on the table with the arc side facing down, it became unstable, and as a result, the student placed their hand on the material.

Furthermore, the student was a special auditing student from a foreign country and had no experience working with similar equipment. For the first 30 minutes of the work, a first-year master's student operated the machine and gave guidance while showing a model of a series of operations using this machine. Afterwards, the student in question conducted the work while the first-year master's student checked the operations for approximately two hours, but the accident occurred when the master's student looked away for a moment.

6. How to prevent this

(1) Reinforce the confirmation of advance safety guidance from the academic supervisor.

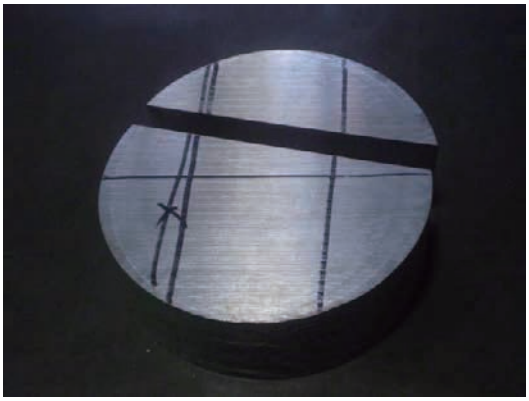
Provide a "safety guidance completed mark" column from the academic supervisor on the usage application form.

(2) Tighten the attendance of safety training sessions.

Prohibit the use of devices unless the person has conducted the beginner's training for each device.

Post "Usage guidelines" and "prohibited matters" for each device, and have students understand the safety precautions prior to use.

(3) Conduct risk assessments on equipment owned by the work center to strengthen safety measures.

	① Tsune Seiki band saw cutting machine where accident occurred Exterior photograph of TB4-262GN This is a cutting machine for cutting large samples such as metal. The material is pinched with the hydraulic cylinder-type main vise A and fixed, after which the sample is cut.
	② Metal material that was planned to be cut in this experiment Sample dimensions: Diameter 175 mm Height 55 mm
	③ At the time of the accident, the person (user) placed the semi-circular material with the arc side down as shown in the figure on the left, put their hand on the material, and tried to fix the vise so that the material would not move.
	④ The student pressed the “close” button of the main vise when fixing the material manually, with the left thumb inserted between the main vise and material; consequently, the left thumb was pinched. The first-year master’s student who was next to the student noticed the accident, pressed the open button on the main vise to remove the load, and reported it to the staff at the work center.

Accident example 14	**Chemical burns caused by concentrated sulfuric acid**
Overview	**A beaker, which contained a strongly oxidizing solution, slipped out of the hands of a student and broke, and the solution spilled on the student's limbs.**

1. When

During a research experiment in the laboratory (weekday, around 1:00 p.m.)

2. Where

On-campus joint education and research facility laboratory

3. What kind of accident

A fourth-year undergraduate student accidentally dropped a beaker (500 ml) that contained concentrated sulfuric acid and a small amount of potassium nitrate. The beaker broke in the draft, with the solution spilling on both the hands and feet of the student. The affected area turned yellow due to the reaction between the nitric acid and protein.

4. How was this handled

The student immediately washed the exposed part with running water. Afterwards, a shower head was attached to a hose outdoors and used to wash the student with running water. The student was transported to the hospital and treated by a physician. The doctor allowed the experiment to resume the next day, and the wound was completely healed after three days. This did not become a severe incident because a large amount of running water was used to wash the affected area immediately after the solution came into contact with the skin.

5. Cause of accident

Because the student rushed the experimental operations, they tried to lift the beaker that was covered with cling film by the top of the beaker. This caused it to slip out of the student's hand. Instructions were to handle this with gloves, but the student did not follow this rule.

6. How to prevent this

The student should wear chemical-resistant gloves and hold the beaker firmly from the side. The student should concentrate on the operation during the experiment, and ensure that it is done carefully. The student should wear safety glasses to protect the eyes. An operating procedure manual that included possible dangers was already posted, but this will be improved to make it more visible.

If such an incident occurs again in the future, washing the affected area with a large amount of flowing water as quickly as possible is effective and important.

Accident example 15	**Fire caused by forgetting to turn off power supply**
Overview	**The heater in the plastic bucket was overheated, the water in the bucket evaporated and became "empty," the heat of the heater ignited the plastic,** and **the fire spreading to a part of the laboratory.**

1. When

Weekend, around 10:30 a.m.

2. Where

Doctoral experiment building, 3rd floor

3. What kind of accident

The water around the heater that was installed in the plastic water tub, which was part of the water treatment experimental equipment, evaporated and became empty". The plastic burned in flames under the effect of heat. There was nothing flammable around the device, but this melted the plasterboard ceiling, and there was damage to two fluorescent lights, a ceiling speaker, test device body, and a laboratory table with a sink.

The test device body had been inactive for six days prior to the completion of the experiment by the master's student. The heater (power consumption 1 kW) was energized and the temperature in the laboratory dropped, so it was thought that the heater thermostat was activated, the water in the water tub gradually decreased, and became empty. The thermostat was set to operate when the water temperature dropped below 28 °C.

4. How was this handled

An energy center staff member who rushed to the site owing to the fire alarm discovered the fire and extinguished it using a fire extinguisher (one extinguisher used). The energy center staff member reported to the executive office staff and contacted the instructor in charge. The fire broke out on a weekend, and the person in charge of the experiment was absent.

5. Cause of accident

(Artificial factors) When putting a device out of operation, the power supply of the heater needs to be cut (i.e., unplug from the outlet), but the student forgot to turn the heater off.

(System factors) The heater did not have an emptying prevention function.

6. How to prevent this

(1) Hold safety and health meetings in the laboratory as soon as possible, and thoroughly implement management and operation methods after considering risk countermeasures for equipment, including heat sources.

(2) When putting the device out of operation, ensure that the power supply of the device that generates heat (e.g., heaters) are also turned off. We will post operation manuals, instructions, etc., in a noticeable location.

(3) Install a device that automatically turns the heater off when the water level drops and a device that stops the heating function when the container is empty.

7. Other

(1) Presence or absence of SDS creation of device: absent (because there was no legally managed object).

(2) Presence or absence of experimental manual in environment/construction system and presence or absence of

experiment safety guidance implementation. Experiment safety guidance for all students were conducted at the beginning of student experiments in the 3rd year of the environmental systems engineering course using safety guides, videos, etc. However, the water treatment test device in this incident originally involved the development of the device, and there was no manual for the test device.

Burned test device: black container in middle is plastic water bucket

Fluorescent ceiling lamp

Plastic cover of ceiling speaker that was melted with heat

Accident example 16	**Ignition of organic solvent during experiment**
Overview	**Organic solvent was ignited during an experiment that involved the application of a pulsed laser to an organic solvent in which fine particles were dispersed. In a haste to deal with it with bare hands, the student suffered burns on both hands.**

1. When

During experiment in laboratory (weekday, around 11:50 p.m.)

2. Where

Machinery building No. 2, 7th floor (Laser application laboratory)

3. What kind of accident

A first-year student in the Department of Electrical and Electronic Information Engineering:

① started an experiment where an organic solvent (propanol), in which fine particles were dispersed, was placed in a 100-cc beaker, to which a pulse laser (KrF, 248 nm, ~120 mJ) was irradiated (in-liquid laser ablation).

② After the start of the experiment, the vaporized organic solvent ignited for some time, and a pillar of fire rose for a moment.

③ The student attempted to carry the beaker to the sink in a hurry with their bare hands but could not stand the heat and dropped it away.

④ The blackout curtain ignited, but there was no damage due to the use of fire protection. A nearby cushion was slightly burned. Organic solvent was spilled on the student's hands, ignited, and resulted in burns on both hands.

4. How was this handled

A fire alarm went off, and the student in question who came out of the laboratory was discovered by a student from another laboratory, and they requested an ambulance. The mechanical system instructor also confirmed the fire alarm and notified the emergency contact network. The student was taken by ambulance to Tachikawa General Hospital, where they underwent examinations and returned to the laboratory.

The fire department arrived and confirmed the site; the next day, the fire department and police verified the site.

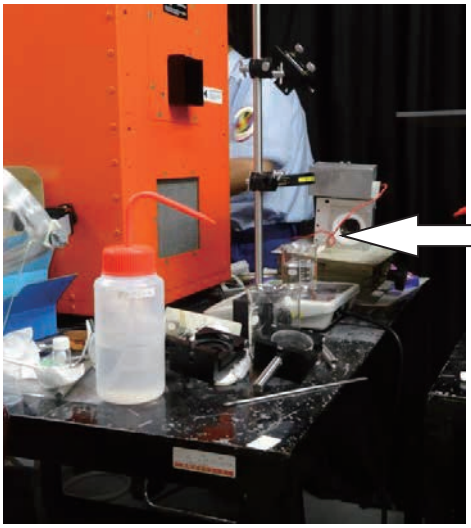
5. Cause of accident

Prior to the accident, experiments were conducted using water. The academic supervisor was planning to conduct experiments by mixing propanol and water in the future when experiments did not progress well with just water, but the student conducted the experiment with propanol (100%). The student conducted the experiment alone late at night, and furthermore, was agitated by the pillar of fire, and was unable to take appropriate measures, such as extinguishing the fire by covering the beaker.

6. How to prevent this

When conducting experiments that could be dangerous after 21:00, make sure to sufficiently plan with the academic supervisor, and a notification of remaining after hours should be submitted. When conducting the

experiment, the academic supervisor should be present with the student to conduct the experiment, or alternatively, experiments should be conducted with two or more students. When conducting experiments with just students, the academic supervisor should always be reachable by phone.



Beaker (recreating scenario of the accident)

Ignited cushion

Accident example 17	**Fire due to malfunction of drying furnace**
Overview	**When the drying furnace was operated to remove rust from the reinforcing bars, the temperature-limiting device malfunctioned due to the deterioration of the drying furnace, so the temperature continued to rise and a fire broke out. The tools, electric wires, measuring appliances, etc., on the drying furnace were burned as a result.**

1. When

During experiment in laboratory (weekday, around 12:00 a.m. – 4:00 a.m.)

2. Where

Large-scale experimental building

3. What kind of accident

In order to remove rust from the reinforcing bars, a 10% aqueous diammonium citrate solution and reinforcing bars were placed in a plastic container and placed in a drying furnace that was set to 60 °C. Due to the deterioration of the drying furnace (made in 1975), the temperature limiting device was malfunctioning, and the temperature continued to rise, so a fire broke out either inside the furnace or near the exhaust port, resulting in the burst of tools, electric wires, measuring appliances, etc., that were on the drying furnace. There were few combustibles in the surrounding area, so the fire was extinguished spontaneously, and only the drying furnace and the items above it were burned.

4. How was this handled

The fire broke out in the middle of the night, and there was nobody in the room. A patrolling energy center staff member discovered smoke in the hallway of the second floor on the Machine Building No. 1, checked the surroundings, and found the location of the fire on the same day. The fire was already extinguished at this stage. Afterwards, the faculty and staff confirmed the situation, saw that the breaker of the burnt distribution panel was turned off, and there was no risk of a second fire.

5. Cause of accident

(Equipment factors)

The drying furnace was deteriorated, and the temperature limiting device was malfunctioning.

(Environmental factors)

There were combustible items on the device.

(Human factors)

Two days before the fire, another student conducted the same work, and there was an incident where the plastic container, which usually does not have any problems, had melted, and deformed. The possibility that the device is malfunctioning should have been confirmed at this stage, but the student did not contact the instructor and left this alone.

6. How to prevent this

(1) Inspect similar equipment.

(2) Do not place any combustible items around a device that may generate heat or catch fire.

(3) When a device malfunctions or exhibits abnormalities, immediately cease its use, contact the faculty and staff, confirm the cause, and take the proper measures. Inform all laboratory users on these aspects.

Burnt drying furnace

Accident example 18	**Puncture injury**
Overview	**During an organic synthesis experiment, the right hand, which was holding an injection needle while trying to conduct delicate work, quivered and the needle stabbed the student's left wrist.**

1. When

During experiment in laboratory (weekday, around 5:00 p.m.)

2. Where

Environmental system building

3. What kind of accident

When conducting an organic synthesis experiment, the student accidentally stabbed their left wrist with an injection needle.

Affected area that was swollen due to internal bleeding

4. How was this handled

As the bleeding quickly stopped at the time of the accident, the student decided that a bandage would be sufficient. However, perhaps due to unconsciously scratching the affected area because of itchiness, the student exhibited swelling due to internal bleeding the following week; hence, the student visited the Physical Education and Health Center for medical examinations.

5. Cause of accident

This was considered to be due to tremors caused by nervousness when attempting delicate work, thus causing trembling of the right hand that held the needle.

6. How to prevent this

The laboratory should be informed of the dangers of using injection needles in experiments and ensure safe handling. Additionally, thorough guidance should be given to the effect of even minor accidents and injuries in the laboratory, and such damages should be immediately notified to instructors in the laboratory. The instructors should provide the necessary measures. Students should be thoroughly informed on the storage location of emergency supplies that are needed for first aid, such as disinfectants and bandages.

Accident example 19	**Small fire in laboratory**
Overview	**When cleaning an asphalt container, the flame of the stove ignited the waste cloth, and the flame of the ignited waste cloth spread to another waste cloth that was wet with a small amount of kerosene nearby.**

1. When

During experiment in laboratory (weekday, around 11:52 a.m.)

2. Where

Machine construction building No. 4

3. What kind of accident

Cleaning the asphalt container involves heating the container with an open flame of a stove to reduce the viscosity of the adhered asphalt and then wiping it with a waste cloth. During this time, the waste cloth touched the flame of the stove, thereby igniting the waste cloth. The flame of the ignited waste cloth then spread to another nearby cloth that was impregnated with a small amount of kerosene. As a result, the waste cloth and the worker's work gloves were burnt, smoke was generated, and the fire alarm was activated.

4. How was this handled

The burning of the waste cloth was minor, so the student shook it with their hands to extinguish the fire. The student was wearing two work gloves and was able to extinguish the fire manually.

5. Cause of accident

The fire was generated by cleaning using a waste cloth and leaving a waste cloth that contained kerosene.

6. How to prevent this

Ensure that the waste cloth with kerosene is separated from the waste cloth without kerosene and stored in an appropriate position. Additionally, do not heat and clean the asphalt container with a flammable material nearby, let alone a waste cloth that is impregnated with kerosene.

Asphalt container, stove, and waste cloth

Setting of the room when the fire occurred

Accident example 20	**Fire in chemical heat storage experimental device during experiment**
Overview	**During the heating of oil by a throw-in-type electric heater as part of preliminary preparation for an experiment using a chemical heat storage experimental device, a fire broke out from the oil in the container.**

1. When

During experiment in laboratory (weekday, around 2:25 p.m.)

2. Where

Shared-use laboratory building

3. What kind of accident

As part of preliminary preparation for an experiment using the chemical heat storage experiment device, a student was heating oil (flash point of approximately 220 °C) in a throw-in type electric heater. The experiment that should normally be conducted by two people was conducted by one person, and the student momentarily left the scene while the oil was heating up to the target temperature of 120 °C. When the student returned to the scene, a fire broke out from the oil in the container where the electric heater was installed.

4. How was this handled

A permanent fire extinguisher was used to extinguish the fire around the device, the power breaker was turned off, and the laboratory shutter was opened for ventilation. Furthermore, fire extinguishing activities were conducted with another individual who came to help, and the fire was extinguished 5 minutes later from discovery. Afterwards, the fire department was notified.

5. Cause of accident

(Device factors)

The electric heater was immersed from the top of the container that contained the oil, so it is possible that the oil that was heated above the flash point by the electric heater rose along the surface of the electric heater, touched the air, and ignited.

(Work method factors)

An experiment that should normally be conducted by two people was conducted by one person, and the student left the scene while heating the oil.

6. How to prevent this

(1) For the device, an oil stirring bypass route should be installed and the oil should be constantly circulated by a circulation pump to minimize the temperature unevenness of the oil in the container. Set the circuit such that it does not turn on the electric heater if the circulation pump is not operating. Additionally, install a temperature raise prevention device that turns off the electric heater when an abnormal value is detected by the installed multiple temperature sensors.

(2) Do not leave the scene during experiments, and constantly monitor the oil temperature.

(3) Regularly review the experiment manual and keep it on site.

Container in which oil was heated with the electric heater (after the fire was extinguished)

Electric heater that was installed in the container that contained oil

Accident example 21	**Accident in which the thumb was caught between a universal testing machine and a test jig**
Overview	**In the attempt to attach a test jig to the universal testing machine, the portion up to the first joint of the right thumb, which was supporting the test jig, got caught between the jig and the universal testing machine and led to a tear injury of the fingertip.**

1. When?

This occurred while conducting an experiment in the laboratory (Saturday, around 1:15 p.m.)

2. Where?

In a shared-use experiment building

3. What kind of accident occurred?

A student in the Materials Engineering Department was trying to support a test jig with the right thumb to attach the jig to the universal testing machine. The student moved the mounting movable part downward when the half of the first joint of the right thumb got caught between the two devices.

The victim was working alone when the accident occurred; the tip of the right thumb tore apart, the bones were visibly crushed, and the nail came off.

4. How was this handled?

The mounting movable part was moved upward immediately on realizing that the right thumb was caught.

The wound was bandaged with a clean cloth, after which the victim went to the Nagaoka Red Cross Hospital and received treatment.

5. What was the cause of the accident?

In order to reduce the work time, the procedure followed was different from the instructions mentioned for jig mounting.

6. How can this be prevented?

(1) Follow the instructions correctly for the procedure as mentioned when doing the work.

(2) Attach the jig mounting procedure chart to the testing machine body to prevent mounting by the wrong method.

[Circumstances at the time of the accident]

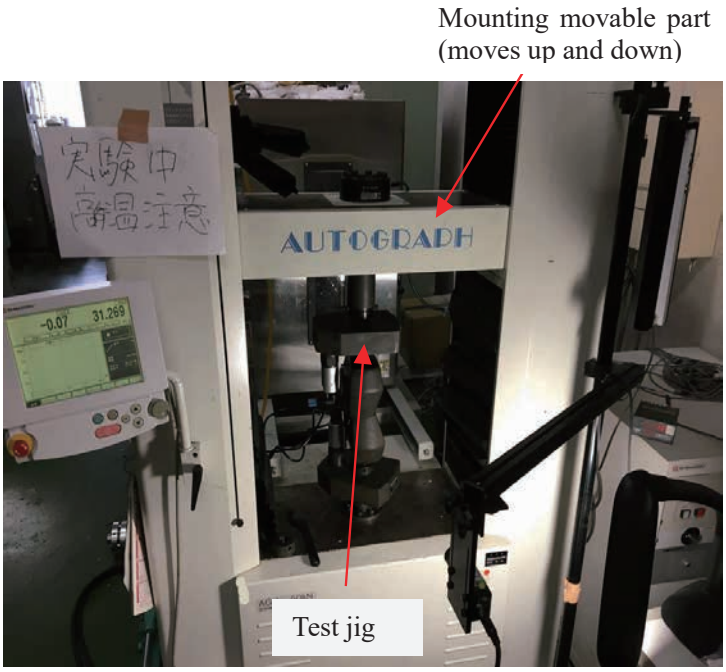


Photo 1 Photograph of the universal testing machine

2. Position to support the test jig

① Alignment markers were included so that the universal joint and set pin of the upper jig could be easily inserted, and a spacer for height adjustment was attached to the upper jig (Fig. 1). As a result, the lower surface of the universal joint and upper surface of the spacer could be moved up instantly prior to contact, and it was confirmed that the set pin could be easily inserted if the alignment markers are matched.

② The procedure was changed so that the installation of the upper jig was done before the lower jig was attached in order to prevent the jig from falling when attaching to the upper jig. The upper jig was placed on the lower table (Fig. 2) and connected to the universal joint, after which the upper table was moved upward and the lower jig was attached, which enabled the safe connection of the upper jig and the universal joint.

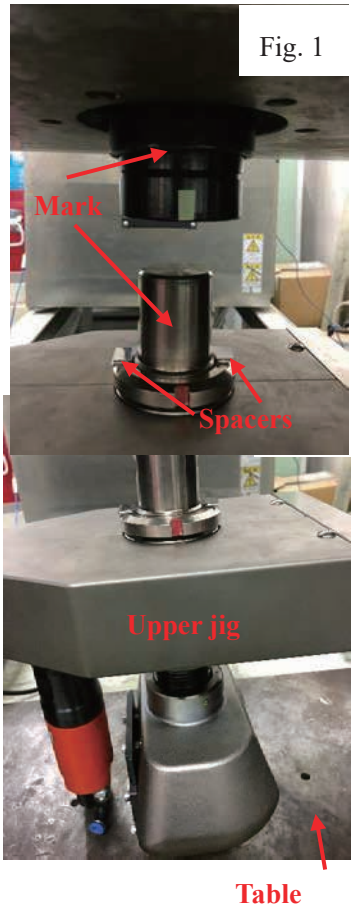


Fig. 1

Accident example 22	**Ignition accident during a heating experiment with cutting oil**
Overview	**When an oil mist evaluation device was used to conduct a capture experiment using cutting oil with a filter, the oil became ignited. No human damage was reported.**

1. When?

During an experiment in the laboratory (weekday, around 2:00 p.m.)

2. Where?

In the Materials Building No. 2

3. What kind of accident occurred?

A third-year undergraduate student was conducting an experiment all by him/herself. Cutting oil (Yushiroken GTS-100, flash point 150°C) was poured into a glass petri dish (22 cm diameter x 5 cm height) in the oil mist evaluation device and heated to a temperature of 110°C using a thermal link electric stove, which led to the oil becoming ignited and caused a fire. The evaluation device is built in such a way that the oil mist in the oil heating section is sucked through the duct pipe by a blower and guided to the filter section. The objective of the experiment was to capture the oil mist generated by this process using a filter. During suction with a blower, fire occurred approximately 10 minutes after heating commenced. Fire broke out at a temperature of 110°C, as seen from the measurement on the thermocouple at this time.

4. How was this handled?

As soon as the fire broke out, another student entered the room, and the two of them tried to extinguish the fire with a fire extinguisher, but they were unable to pull out the safety pin and operate the fire extinguisher properly. Later, with the help of some of the staff on the same floor, the fire was extinguished using a fire extinguisher. At almost the same time as the start of the fire, the fire alarm went off and announcements for safety began through voice guidance throughout the building. On hearing these, another staff member came and evacuated the students in question as well as other students on the same floor. Smoke from the combustion of the cutting oil and equipment parts filled the room, and the acrid odor of burning oil drifted down the hallway. Staff members split themselves into groups quickly evacuated faculty and students on the other floors and led them outside to safety. They then conducted on-site confirmations while opening the windows and waited for the smoke and odor to subside. The facility staff contacted the Nagaoka Fire Department, after which an investigation and inspection were conducted by the fire department.

5. What was the cause of accident?

The instructions were that heating should be gradual and that high temperatures should not be attained.

However, to capture a large amount of oil mist with the filter, the student conducted the experiment under rapid temperature rise settings.

The experiment calls for oil to be poured into a tin can and heated, but the student changed the specifications of the device at his/her own discretion, poured oil into a petri dish made of ordinary glass, and heated it. It is possible that oil may have leaked through a crack in the petri dish and caught fire at the thermocouple section.

The student panicked as soon as fire broke out and was unable to operate the fire extinguisher to put out the fire.

6. How can this be prevented?

(1) Do not conduct experiments alone.

(2) Do not conduct experiments based on expectations and implement changes in device specifications.

(3) Do not panic in the event of an accident.

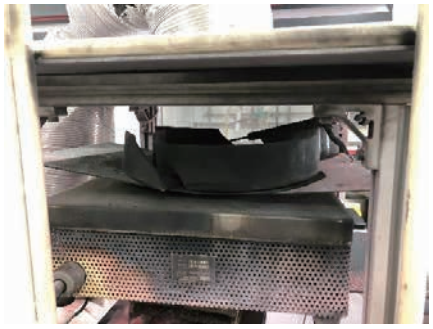
[Site photographs]

As shown in the oil mist evaluation device 3, the developed filter is contained in the cylindrical part on the left side, and the oil mist that is generated in the oil heating part is guided to the filter through the aluminum duct tube above the suction section by the blower on the far right. After the accident, the glass petri dish was broken, as seen from the photograph of the oil-heating part and the oil-receiving part, and the oil that was spilled from the oil-receiving part was accumulated in the lower part of the jack around the oil-heating part.

Oil mist evaluation device 1

Oil mist evaluation device 2

Oil mist evaluation device 3



Oil-heating part

Damaged oil-receiving part

Around the oil-heating part

Accident example 23	**Hand injury due to breakage of quartz tube while encasing a metal sample in the quartz tube**
Overview	**While attaching the quartz tube to the hose, more force than necessary was applied leading to breakage of the quartz tube and causing a deep cut injury from the base of the left thumb to the base of the index finger.**

1. When?

During an experiment in the laboratory (weekday, around 1:00 p.m.)

2. Where?

In Machinery / Construction Building No. 3

3. What kind of accident occurred?

A student in the Mechanical Engineering Department was conducting an experiment that required a metal sample to be placed within a quartz tube. The contents within the tube were drawn out and vacuum sealed. When connecting the quartz tube with a diameter of 20 mm (outer diameter of approximately 23 mm) to a hose with an inner diameter of approximately 22 mm that was connected to a rotary pump, the student tried to force the tube into place. The quartz tube broke, and the student's left hand sustained a deep gash around five cm long (from the base of the thumb on the back of the hand to the base of the index finger) and started bleeding.

4. How was this handled?

The student tried to stop the bleeding on the way to the first aid block in the physical education and storage center; soon the nurse on duty helped stop the bleeding. The student then went to Nagaoka Red Cross Hospital along with the academic supervisor and was immediately treated at the emergency outpatient department. Since the student's thumb tendon and artery were cut, the student was hospitalized immediately. Following surgery at 5:00 p.m., the student was hospitalized for two nights for follow-up observations.

5. What was the cause of the accident?

Normally, the hose is inserted into the quartz tube or removed from it by applying vacuum grease so that it slips into position or detached easily from the tube. However, the student was not aware of this and tried to fix the quartz tube to the hose using force. At the time of the accident, no vacuum grease was placed around the experimental equipment.

The inner diameter of the quartz tube was large (20 mm) to suit experimental conditions, and the hose wall thickness used was too thick, while the inner diameter of the hose was too small. Risk assessment at the time of changing the experimental conditions was not conducted.

6. How can this be prevented?

(1) Conduct safety checks and work according to the instructions given in the procedure chart.

(2) Post the precautions for the experiment in the immediate vicinity of the sealing worksite.

(3) Provide safety instructions as a way of warning whenever a new student is assigned.

(4) Place the items necessary for the experiment (i.e., protective glasses, gloves, face shield, vacuum grease) in designated positions right next to the sealing worksite.

(5) Use appropriate protective equipment depending on the experimental technique and risk such as a standard-compliant product (ANZI Z87, Class 1, etc.) for protective glasses and cut-resistant gloves (EN388 Level 5).

(6) Conduct risk assessment, explain the importance of risk prediction, and take precautions against possible danger.

[Circumstances at the time of accident, measures]

Connecting quartz tube to hose

Inside of the vacuum hose

Place items required for the experiment in the immediate vicinity of sealing worksite

Accident example 24	**Fire on a weekend night**
Overview	**Fire broke out on and around the lightweight workbench. No human damage was reported.**

1. When?

During an experiment in the laboratory (weekend night, around 12:10 a.m.)

2. Where?

In Machinery / Construction Building No. 2

3. What kind of accident

While the equipment was operational and unattended all night, a fire broke out, which burned items on and around the lightweight workbench.

The device that was operating unattended was not connected to the extension cord set, which is presumed to be the source of the fire.

The magnetic stirrer that was connected to the desktop drafter and the extension cord set on the lightweight workbench were non-functional at the time of the fire.

4. How was this handled?

A staff member of the university who rushed to the scene when the fire alarm sounded reported the incident to the fire department. A security guard of the university brought a fire extinguisher to the scene, but the fire could not be extinguished due to the strong smoke and heat.

A room on the same floor had lights on, and hence, the staff member went around to announce the outbreak of fire. However, the room was empty; perhaps the persons in it had already evacuated. Fire extinguishing activities were conducted by the fire brigade, and the fire was extinguished an hour and 20 minutes after it fire broke out.

On-site inspections were conducted by the fire department and police on the morning after the fire.

5. What was the cause of the accident?

On-site inspections by the fire department, police, and forensics revealed that the extension cord set placed on the lightweight workbench burned violently, and that something on the lightweight workbench caught fire due to electrical factors. The fire that started from the extension cord set may have been high. Although it could not be definitively concluded whether it was the extension cord set itself or a device that was connected to the extension cord set at the time that caused the fire, it was speculated that the problem lay with one of these two devices. The cause was not specified, but possibilities included the heating of the tracking or AC adapter.

6. How can this be prevented/

(1) Attach a safety cover to the plug in order to prevent tracking.

(2) Attach an outlet cap to empty outlets in order to prevent dust from gathering.

(3) Further, use a storage box if there is no choice but to place the power strip in a place where a large amount of dust can gather.

(4) Pay attention to the power consumption of the connected device in order to avoid exceeding the cable capacity.

(5) Regularly inspect outlets, extension cords, etc., and replace all extension cord sets with products that have the “PSE” mark or are PSE “compliant”.

(6) Make sure to unplug unused devices.

[On-site photographs]

Small electric furnace that was in operation at the time of the fire

Location of fire (after removing lightweight workbench)

Extension cord set that was presumedly the source of the fire

The desk drafter (almost burned down) that was installed on the lightweight workbench and the magnetic stirrer that was installed on the desktop drafter (power supply is connected to the extension cord set on lightweight workbench)

* Not in operation at the time of the fire.

Lightweight workbench on which equipment that was presumedly the source of the fire was placed

Accident example 25	**Fire due to mismanagement of experimental waste**
Overview	**When samples that were heated in experiments were discarded without following protocol, the dust in the trash can ignited. No human damage was reported.**

1. When?

During an experiment in the laboratory (weekday, around 2:00 p.m.)

2. Where?

Experimental Training Building No. 2

3. What kind of accident occurred?

A graduate student and an undergraduate student from the Department of Mechanical Engineering dumped biomass (sugarcane) that was heated during an experiment into the trash can after cooling it in air, which led to a fire. The combustible waste in the trash can was ignited due to insufficient cooling.

4. How was this handled?

A university staff member who passed by the site saw smoke coming out of the trash can that was covered with a lid. On opening the lid, it was seen that a part of the paper and cardboard waste in the trash can was on fire. Hence, water was quickly sprinkled on it to extinguish the fire.

5. What was the cause of the accident?

Normally, after a heating experiment, biomass is transferred to a stainless steel container, cooled in air for approximately 15 minutes, sprinkled with water to douse any remnants of fire or heat, and then discarded as general combustible waste.

In this case, considering the danger of sprinkling water on biomass, which was at a high temperature of over 100 °C, and the hassle of drying the wet biomass, an on-site decision was taken to cool the biomass in the stainless steel container and discard it without extinguishing the fire with water. The decision was taken based on the fact that the biomass in the stainless steel container had no flame or red heat (high-temperature light emission), and that the stainless steel container walls were about the same temperature as room temperature. However, the temperature did not drop sufficiently, and the combustible items in the trash can (e.g., paper scraps) were ignited.

When the cooling method was changed, the procedure manual was not changed; nor were checks conducted by the related parties, and hence, an on-site judgment was made rashly. Hence, the risk assessment of the work was insufficient.

6. How can this be prevented?

(1) Adopt a more reliable method for cooling the biomass after conducting the heating experiment as usual.

(2) Specify the following items as post-treatment (i.e., cooling) in the procedure manual for the biomass heating gasification experiment

1. Place the biomass after the heating experiment in the stainless steel container and cool it in the open air.
2. Check the temperature of the biomass using thermography or a thermometer.
3. Sprinkle water until the entire mass is soaked.
4. Confirm that any sign of fire is extinguished by the absence of bubbles or water vapor.
5. Store the mass in a heat-resistant container (heat-resistant trash can) in the laboratory for a week.
6. After the biomass has dried completely, dispose of it as combustible waste.

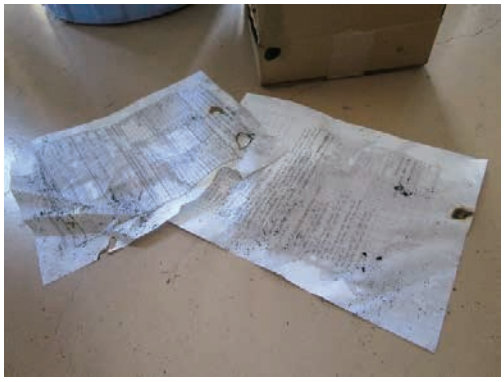
Note: If the temperature of the biomass or the stainless steel container is high, do not touch these objects with bare hands until the mass is cooled and the temperature is checked using thermography or a thermometer.

(3) Every year, ensure the risk assessment of potential risks is strictly conducted for each experiment to improve the awareness of those involved in conducting the experiment.

(4) Even for trivial changes in procedure, hold meetings with the people involved in the experiment, including the faculty members, and conduct risk assessments.

[On-site photographs]

Smoke was coming from the second trash can from the right.



Ignited garbage

Part of the paper waste and cardboard burned

Accident example 26	**Contusion wounds of the fingers of left hand while dividing plate-shaped asphalt concrete debris by strike**
Overview	**While smashing the plate-shaped asphalt concrete debris onto the floor outdoors, fingers were caught between the debris and the floor, resulting in contusion wounds.**

1. When?

After research experiment (weekday, around 4:00 p.m.)

2. Where?

Outside of Faculty Bldg. 4 (Mechanical Engineering and Civil Engineering)

3. What kind of accident occurred?

A student in the Civil and Environmental Engineering smashed the asphalt concrete debris onto the floor outdoors to dispose of the debris after cutting a cylindrical specimen from a plate-shaped asphalt concrete block. The three fingers of left hand were caught between the debris and the floor, resulting in contusion wounds. There were no fractures or infections.

4. How was this handled?

At the time of the accident, the student was working with two other students. The student was in severe pain and immediately ran to the physical education and storage center, but the nurse on duty was not there. So the student asked for help from Division of Student Affairs and explained the situation to the staff. The staff did medical examination procedures and the manager took and picked up to the medical institution. There is no abnormality on the bone, so the doctor treated with ointment and a bandage, and the student returned to the university.

5. What was the cause of the accident?

Although other work methods, such as smashing them with a large hammer or disposing of them without breaking them, could have been used, the students forcibly tried to rely solely on their own strength. In addition, the student themselves thought they could do the work.

6. How can this be prevented?

(1) Provide safety guidance and safety education.

(2) Compile and post the precautions for the experiment.

(3) Provide safety instructions as a way of warning periodically.

(4) Conduct risk assessment, make recognized the importance of risk prediction, and do training against possible danger.

[Circumstances at the time of accident]

Situation of accident scene

Plate-shaped asphalt concrete debris that caught fingers

Accident example 27	**Ignition of tubular electric furnace rubber stoppers**
Overview	**While the tubular electric furnace was operating at 1000°C, silicone rubber stoppers at both ends of the mullite tube, which had Ar gas flowing through it, were heated and ignited.**

1. When?

During an experiment in the laboratory (weekday, around 5:00 p.m.)

2. Where?

Extreme Energy-Density Research Institute

3. What kind of accident occurred?

While the tubular electric furnace was operating at 1000°C, silicone rubber stoppers at both ends of the mullite tube, which had Ar gas flowing through it, were heated and ignited.

The electric furnace and temperature control were commercially available, the wiring was self-made, and the temperature was measured with a K thermocouple at the port specified for the electric furnace. The measured value that visually confirmed when the power was turned off was 999°C, which was a good control for the setting of 1000°C.

4. How was this handled?

A student in another lab reported "smoke" and the student used a fire extinguisher to extinguish the fire.

No injuries and equipment damage.

5. What was the cause of the accident?

The silicone rubber stopper overheated because of a recent low-temperature heating experiment, in which a 600-mm-long mullite tube was used to heat the stopper to 1000°C. In addition, students had to leave the room for seminars and other activities after setting the timer and temperature to keep the temperature at the desired level.

6. How can this be prevented?

Take the following measures to prevent the silicone rubber stopper from overheating.

(1) Replace with a mullite tube of 800 mm (special order) or 1000 mm (commercially available) longer than the 600 mm length in question.

(2) To prevent further heating, add rock wool insulation to the silicone rubber stopper.

(3) Remind students again at the regular annual safety education.

[Circumstances at the time of accident]

Tubular electric furnace

Silicone rubber stopper

Instructions regarding experiments conducted for unavoidable reasons over holidays or unmanned overnight

When conducting an experiment for unavoidable reasons over the holidays or overnight, please follow the instructions of the concerned faculty member and ensure that all measures are taken to prevent accidents.

1) In cases when an experiment or research needs to be conducted during the holidays due to unavoidable reasons, please pay attention to measures for safety, fire prevention, etc.

- **Experiments are to be conducted strictly with the approval of the academic supervisor, and sufficient instructions should be received from the academic supervisor in advance.**

2) In cases when an experiment or research needs to be conducted all night without being manned for unavoidable reasons please pay attention to measures for safety, fire prevention, etc.

- **Experiments are to be conducted strictly with the approval of the academic supervisor, and unmanned operation is not to be conducted when there is risk of danger.**
- **Ensure that the "notice for remaining after hours" and "unmanned operation all night" are posted on the entrance of the laboratory (please check p3 "Appendix 1 Procedures for after-hours experiments, etc." for details).**