Generic Foreign Material Exclusion

National Academy for Nuclear Training eLearning System (NANTeL)

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# Generic Foreign Material Exclusion Training

**Course Title:** Generic Foreign Material Exclusion Training  
**Course Owner:** Jim Caulk

## Revision History

<table>
<thead>
<tr>
<th>Revision Date</th>
<th>Version Number</th>
<th>Purpose for Revision</th>
<th>Performed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/09/08</td>
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<td>Updates to content, exam questions, and interactions based on review of exam history and student feedback.</td>
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</tr>
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<td>Changes to exercises: Bad Tool ID and Close-out Inspection</td>
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</tr>
</tbody>
</table>
| 3/18/09       | 09.00          | • Added reference to vacuum build-up in pipe dam section  
• Revised fail-safe definition  
• Added “Initial Internal Inspection” page to Work Practices section  
• Changed “Material Control Log” to “Material Accountability Log”  
• Revised/updated photos and graphics  
• Modified exercises for clarity and ease of use  
• Revised multiple exam questions based on student feedback and exam analysis | Jim Caulk  |
Generic Foreign Material Exclusion Training

Course Goal: The course teaches students to identify and use basic Foreign Material Exclusion (FME) work practices so they can prevent foreign material from entering plant equipment.

Course Objectives:

Introduction

- Define the term Foreign Material (FM) and identify sources of Foreign Material.
- Explain the purpose of Foreign Material Exclusion (FME).
- Describe the potential impact of FM on plant systems.
- Identify when and where a station is most vulnerable to Foreign Material Intrusion (FMI).

FME Areas

- Define the terms FME Area and FME Boundary.
- Describe how FME Areas are classified.

Responsibilities

- Describe the individual’s responsibilities for FME.
- Define the term FME Monitor and describe the responsibilities of an FME monitor.
- Describe the FME responsibilities of oversight personnel.

FME Work Practices

- Define the terms “Fail-Safe” and “Immediately and Safely retrievable.”
- Describe how to create a Fail-Safe environment.
- Describe basic FME work practices, including the following:
  - Assessing tasks for FM concerns
  - Establishing FME boundaries and controlling access to FME areas
  - Observing good housekeeping and cleanliness practices
  - Controlling FM that is generated as part of work activities
  - Staging tools and materials
  - Securing tools, materials, and personal items
  - Using standard protective devices
  - Controlling the use of transparent materials
  - Working with fuel handling equipment
FME Lesson Plan

- using proper logging and accounting practices
- protecting parts and equipment during transportation

Special FME Considerations

- Describe the role of Human Performance tools in FME.
- Describe precautions to take when operating a crane near FME areas.
- Explain the potential effects of FME controls on plant configuration.
- Identify what actions to take when the FME plan changes.
- Explain the proper response to a loss of FME control

Closeout and Inspections

- Describe proper closeout inspection processes.

Target Audience:

All workers, utility and supplemental.

Developmental Resources:

- EPRI TR-106756, Foreign Material Exclusion Guidelines, February 2005
- INPO SOER 95-1, Reducing Events Resulting from Foreign Material Intrusion, June 1995
- INPO 97-008, Foreign Material Exclusion (FME) Program, July 1997

This lesson plan may be used to support the web-based training course available at https://www.nantel.org
Welcome to

Foreign Material Exclusion

Please select the "Next" button in the lower right corner of your screen to get started.
This course will help you identify and use basic Foreign Material Exclusion (FME) work practices so you can prevent foreign material from entering plant equipment.
Here is a description of your navigation controls.

- **Next**: Advances to the next page in the course
- **Back**: Moves back to the previous page
- **Menu**: Takes you to the course menu page
- **Exit**: Exits the course (you can return to the same location later)
- **Glossary**: Defines key words and phrases
- **Objectives**: Displays the learning objectives
- **Reference**: Displays documents relating to the course subject
- **Feedback**: Opens an e-mail message to send us your feedback
- **Page**: Shows the current and total page numbers in each section
- **Underlined Text**: Indicates a link to additional course material

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**Slide 3**

Slide notes:
Welcome to the menu page.

Please make a selection from the menu at right.

A GOLD star will appear when you complete each topic.

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Objectives

- Define the term Foreign Material (FM) and identify sources of Foreign Material
- Explain the purpose of Foreign Material Exclusion (FME).
- Describe the potential impact of FM on plant systems.
- Identify when and where a station is most vulnerable to Foreign Material Intrusion (FMI)
Everyone comes to work every day planning to do a good job. No one plans to make mistakes.

Unfortunately, as long as there are humans at work, there will be mistakes. And as long as there is gravity, one of those mistakes will be to drop things.

At an industrial facility like a nuclear plant, dropping things can cause big trouble if those things fall into an open piece of equipment.
The Cost of Foreign Material

These photos show the result of leaving a 95-cent roll of paper towels in a turbine system after cleaning. The cost to repair the damage?

$8 MILLION!
There are many ways that material can get into a system or component where it doesn’t belong. It can be dropped in by accident or introduced purposely as part of normal work activities (then missed or forgotten during clean-up).

However it gets in, Foreign Material always means trouble for whatever system it touches. This is why Foreign Material Exclusion (FME) is one of the most important responsibilities for every person who works in a nuclear plant.
Foreign Material

Foreign material (FM) is anything that enters equipment or systems where it doesn’t belong. When this happens it is known as Foreign Material Intrusion (FMI). FM can damage parts and cause equipment or systems to fail.

FM can be something tiny, like a speck of dirt. It can also be large, like an entire hand tool or other large object. Other examples include pens, lanyards, nuts and bolts, washers, broken parts, rags, paint chips, documents, paper clips, trash, chemicals, grinding particles, and sealing compounds. It can even include devices intended to prevent Foreign Material from entering systems.
Consequences of FMI

Foreign Material Intrusion can create safety hazards for workers, cause extensive damage to plant equipment, and result in lost generation time.

FMI has caused many significant problems for the nuclear industry over the years. Pieces of gasket material have blocked cooling water flow to the main generator, causing damage that required a 14-week outage. Parts from a refueling tool have fallen into the reactor’s control rod drive mechanism, preventing the rod from fully inserting into a fuel bundle.
FM and Nuclear Fuel

One of the greatest concerns surrounding FM is the potential for it to damage the reactor’s nuclear fuel. Any small pieces of metal left in the primary system after maintenance activities (such as bristles that fall off a wire brush during cleaning) are swept through the reactor by the flow of the reactor coolant. These small bits of debris can scrape the fuel repeatedly under intense pressure and at a high rate of speed as they cycle through the reactor again and again. This can cause the fuel to leak, which reduces the performance and stability of the fuel while increasing radiation levels in the reactor coolant system.

Click here to see how FM can circulate through the reactor system.
Because of Foreign Material problems and other causes, 17 percent of nuclear power plants in the U.S. were operating with some damaged fuel in 2008. The industry has a goal to operate all U.S. stations with zero fuel failures by 2010. Keeping Foreign Materials out of the reactor system is a vital part of achieving this ambitious goal. This will require the dedicated efforts of every worker on site.
Because of Foreign Material problems and other causes, about 20 percent of nuclear power plants in the U.S. were operating with some damaged fuel in 2006. The industry has a goal to operate all U.S. stations with zero fuel failures by 2010.

Keeping Foreign Materials out of the reactor system is a vital part of achieving this ambitious goal. This will require the dedicated efforts of every worker on site.

Click here to close this window.
When Can Foreign Material Intrusion Happen?

Any system with an opening is vulnerable to FMI. Some locations in the plant, such as the Spent Fuel Pool, have permanent openings that require on-going Foreign Material Exclusion practices. Others, such as the turbine system, steam generators, pumps, valves, instruments, and breakers are opened only at certain times for maintenance or testing.

Condenser Waterbox  Steam Dump Valve  Main Turbine
When is Foreign Material Intrusion Most Likely?

Foreign Material Intrusion is most likely to occur during a plant outage, when many of the plant’s systems are open for maintenance and there is a great deal of activity going on at once. Heightened awareness and special attention to FME is important during this time.
Foreign Material Exclusion (FME) is the process of preventing FM from entering equipment and systems when they are open for maintenance, modifications, tests, or inspections. This process helps ensure that equipment will work the way it was designed. FME keeps the plant and its people safe.
Match the Abbreviations to the Definitions

As each abbreviation is highlighted, select the matching definition. Click the "Begin" button below to start the exercise.

- **FM**: Keeping foreign material out of open equipment.
- **FME**: When foreign material enters open equipment.
- **FMI**: Anything inside a piece of open equipment that doesn't belong there.
Let's Review

Foreign Material is ______________________

- anything in equipment or systems that is not there by design
- only a concern in pressurized water reactors
- material that is purchased from international vendors
- tools, equipment, and materials that should be stored outside the radiologically controlled area
Let's Review

When is a station most vulnerable to Foreign Material Intrusion (FMI)?

- during the night shift
- when the scope of work changes
- during an outage
- when the Foreign Material Exclusion Monitor is on break
Welcome to the menu page.

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Slide 21
Slide notes:
Objectives

- Define the terms FME Area and FME Boundary.
- Describe how FME Areas are classified.
Sometimes a work area requires specific controls to prevent Foreign Material Intrusion during work. In such cases, the area is identified as a Foreign Material Exclusion Area (or Zone).
FME Boundary

The boundary of the FME Area will be clearly marked with signs and the use of tape, ribbon, or rope. Sometimes a buffer zone is also created around the FME Area. If the FME Area requires personnel or materials to be logged in and out, the boundary is created so that entrance to the area can be controlled. Boundaries should be established before equipment is opened.

When the equipment opening is very small and continuously monitored, an FME boundary might not be required. If this type of area is left unattended, it should be capped or plugged with an FME device.
FME Area Classifications

FME Areas are classified by different levels (usually two or three) based on a number of factors.

- The **probability** of Foreign Material Intrusion occurring
- The **difficulty** of detecting or recovering Foreign Material
- The **potential consequences** of a Foreign Material Intrusion event

It is important to understand your station's classification system, so you will know what controls are expected and precautions to take in different FME Areas.
Let's Review

Which is a characteristic of a Foreign Material Area boundary?

- It is established before the equipment is opened.
- It is clearly marked with signs and tape, ribbon, or rope.
- It may not be required if the opening is small and continuously monitored.
- All answers are correct.
Let's Review

One of the considerations used in deciding how to classify the level of an FME Area is the number of qualified workers assigned to the task.

- True
- False
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Objectives

- Describe the individual's responsibilities for FME.
- Define the term FME Monitor and describe the responsibilities of an FME monitor.
- Describe the FME responsibilities of oversight personnel.
Individual Responsibilities

Foreign Material Exclusion is an important safety process. It requires every individual to be alert at all times for potential Foreign Material Intrusion events. Good housekeeping, the use of human performance tools, and a focus on prevention are the keys to successful FME.
Expectations

The following FME expectations apply to everyone on site:

- Know and adhere to FME requirements.
- Minimize the opportunity for Foreign Material Intrusion.
- Help to establish, maintain, or restore FME controls.
- Inspect tools and equipment that will be used near open systems to verify they are in good repair and will not become a source of FM.
- Notify a supervisor of any problems with FME controls.
- While always adhering to safe work practices, limit the time that equipment is open and vulnerable to FMI by completing work in a timely manner.
- Stop work if FME controls may be compromised.
FME Monitors

The FME Monitor controls the FME Area by keeping logs of what enters and leaves the area. A Monitor might also support the work supervisor in monitoring work and addressing FME problems.

The FME Monitor should remain stationed at the work site or access point and limit entry to only essential personnel.
Supervisors

Supervisors play an important part in reinforcing FME work practices. If you are in any type of supervisory, project manager, or lead technician role, you are responsible for any or all of the following:

- Review FME requirements.
- Ensure that the work group has been briefed.
- Ensure that the FME plan is followed or that changes are approved.
- Monitor the FME Area and reinforce FME expectations.
- Address any emerging problems relating to FME.
- Ensure that the equipment is clean before final closure.
- Ensure that appropriate inspections are performed.

Slide notes:
Let's Review

Who is responsible for logging items in and out of the FME Area?

- the work planner
- the supervisor
- the FME Monitor
- the quality control inspector
Let's Review

Who has the responsibility for minimizing the opportunity for Foreign Material Intrusion to occur?
- supervisors
- the Foreign Material Exclusion Monitor
- the Maintenance department
- all employees
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Objectives

- Define the terms "Fail-Safe" and "Immediately and Safely Retrievable."
- Describe how to create a Fail-Safe environment.
- Describe basic FME work practices, including the following:
  - assessing tasks for FM concerns
  - establishing FME boundaries and controlling access to FME areas
  - observing good housekeeping and cleanliness practices
  - controlling FM that is generated as a part of work activities
  - staging tools and materials
  - securing tools, materials, and personal items
  - using standard protective devices
  - controlling the use of transparent materials
  - working with fuel handling equipment
  - using proper logging and accounting practices
  - protecting parts and equipment during transportation
Task Assessment

It is important to approach every task with an awareness of how Foreign Material might enter the system during your work activities. While FME controls are always considered as part of the station's work planning process, every individual must be alert to the specific conditions and FME needs of each task before beginning work.

During the initial field inspection of the work site, be sure to look for potential sources of FM. **Asking yourself the following types of questions before beginning work is the most effective method of preventing FMI:**

- What's in the overhead that might fall into the work area?
- What needs to be cleaned before beginning work?
- Do the current environmental conditions (such as a thunderstorm during work in the switchyard) require work to be rescheduled?
- Are there different tools or materials that you could use to reduce the potential for Foreign Material Intrusion?
- Will other nearby work activities create a Foreign Material hazard?
Establishing Boundaries

Before opening a system or component, establish the FME Area boundaries as appropriate to the job.

- Install boundary markers as close as possible to the system opening.
- Remove non-essential materials.
- Clean the area both within and around the FME boundary.
Looking for Hidden or Infrequent Sources of FM

Inspect overhead gratings, walkways, railings and other structures for dirt and debris that could fall into the FME Area. Look for sources of FM that might occur infrequently in or near the area. Examples include overhead cranes, ventilation ducts, drains, vents, and relief valves. Consider how best to plan for each specific occurrence.
Can You Find the Potential Source of FM?

Click on the potential source of Foreign Material in this picture.
Housekeeping

Housekeeping is the foundation for successful FME. Every individual is responsible for maintaining a clean and controlled work environment.

After equipment has been opened for maintenance or testing, one of the most effective ways to minimize Foreign Material Intrusion is to maintain a neat and clean work place by cleaning as you go.

At the end of a work assignment or shift, the goal should always be to leave the work area as clean as or cleaner than it was.

Slide 42
Slide notes:
Trash

Do not bring trash such as containers, wrappers, boxes, and packing material into the FME Area unless it is required for the job. Do not keep trash cans inside the FME Area. Remove all trash from the area as it accumulates.

In 2004, a reactor scrambled three minutes after returning an Electro-Hydraulic Control pump to service following routine maintenance. The cause? A small piece of shrink-wrap packaging material was left on a replacement filter, which blocked the hydraulic fluid flow.
Tools and Materials

Tools and materials should be clean before bringing them into the FME Area, and should be removed as soon as they are no longer needed.
Let's Review

One of the most effective ways to minimize Foreign Material Intrusion is to ______

- always have an FME Monitor on duty
- clean as you go
- keep equipment openings as small as possible
- always keep a trash can in the FME Area
Initial Internal Inspection

As soon as a system or component is opened, inspect it for foreign material that might already be inside. This is called the "As-Found" inspection. It is one of the two most important inspections you will conduct. The other is called the "As-Left" inspection, which is the inspection you will conduct just before closing the equipment at the end of the job.

If you find any Foreign Material (such as broken parts, dirt, or trash) during the As-Found inspection, stop work immediately. Do not touch or clean it. Contact your supervisor for instructions.

This photo shows debris from a decayed gasket.
Electrical Enclosures

Ensure that all electrical enclosures are free from FM at the end of each task.

*Click on the electrical cabinet to open it up and see if there is any FM inside.*
Chemicals

Make sure that all chemicals and compounds brought into the FME Area comply with plant guidelines. Whenever possible, look for alternative chemicals, such as water in place of metal cutting coolants, to avoid introducing unapproved chemicals into the system. Chemicals that are perfectly appropriate for use outside of equipment can become Foreign Material if they get inside.
Controlling FM Generated During Work Activities

Many work activities generate Foreign Material in the process. This FM can affect the equipment being worked on, as well as other equipment both inside and outside the FME Area.

When one nuclear station replaced a support plate in the reactor vessel, the new plate did not fit. Some grinding was required for modification. This was done over the refueling pool with the support plate out of the water. The grinding work was not in the original FME plan, and workers did not recognize that the grinding would allow debris to enter the refueling pool. This resulted in extensive and expensive cleanup.
What Have We Created?

Hold your mouse over each of the work activities below to see the kind of FM it can create.

Cutting
Spray painting
Sand blasting
Insulating
Welding
Machining
Grinding
Working on or above gratings
Spiral-wound gaskets
Clean Work Residue During and After the Work

Make sure that all residue from work activities is cleaned during and after completing the task. This may require a combination of vacuuming, wiping, flushing, or other methods to ensure all residue is removed.

Special precautions may be necessary for some activities. Consult your supervisor if you are uncertain about whether your work activities might generate FM that could affect other plant equipment.

Good Practice
Openings are taped and vacuum is used during drilling
Staging Tools and Materials

Whenever possible, schedule tool, material, and spare parts requirements in advance. Prepare a staging area for these items convenient to, but outside, the FME Area. Make sure the staging area will not be disturbed or interfere with other work.

Bring items from the staging area into the FME Area only as required to support the work being performed at that time. Collect these items and return them to the staging area or other appropriate location outside the FME Area as soon as practical.
Securing Tools, Materials, and Personal Items

Anything that is brought into an FME Area can become Foreign Material if it is dropped or otherwise accidentally introduced into the open system.

It is best to examine everything that will be brought into the area to determine if it is fail safe or immediately and safely retrievable. **Fail safe** means the material can’t fit through the largest equipment opening. **Immediately and safely retrievable** means that if the item does accidentally enter the system, you could retrieve it quickly and without risk to yourself or the station.

You can also prevent tools and materials from becoming foreign material by installing pipe bladders inside the opening. These will be discussed later in this course.

**Slide notes:**

- **This wrench is fail safe** because it is physically too large to fit in the opening and has no pieces that can fall off. Even if the wrench is dropped, it can’t fall into the system and become foreign material.
- **This wrench must be secured with a lanyard to make it immediately and safely retrievable.** With the lanyard securely attached at both ends, it cannot be left inside the equipment.
Use Lanyards

Secure tools, materials, and equipment through the use of lanyards and similar tie-off devices. The photos below show a variety of methods.

Slide 54
Slide notes:
Attach the Lanyard at BOTH ends

In 2004, a worker at a U.S. nuclear power station dropped a camera into a steam generator. The camera was attached to a lanyard, but the lanyard was not secured to the worker's wrist.
Attach the Lanyard at BOTH ends

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Let's Review

A tool that is too large to fit into an open system is considered Fail-Safe.

☐ True

☐ False
Guidelines for Using Lanyards

Make sure the lanyard does not create a safety or FMI hazard. It should be strong enough to resist breaking if the attached item is dropped.

Inspect the lanyard to ensure it is securely attached.

Choose lanyards made of nylon, rubber tubing, or corrosion-resistant steel. Avoid lanyards made from materials that might chip, flake, or peel.

The lanyards in this picture are not acceptable because they are made from masking tape.
Securing Personal Items

The best thing to do with personal items such as jewelry, watches, pocket change, beepers, and extra pens is to leave them outside the FME Area.

If personal items are brought into the area, they should be properly secured:
- Cover all visible jewelry. Wear cotton glove liners or tape over a jeweled ring.
- Tuck necklaces inside clothing.
- Tape over clothing buttons, badges and dosimetry.
- Secure eyeglasses, safety glasses, hard hats, hearing protection, and other similar items so they cannot become lost if they should fall off while in the FME Area.

In the photo at right, click on the items that need to be secured or removed before entering an FME Area.
Click [here](#) to check your answer.
Keep Parts and Equipment in Good Repair

Tools and equipment entering the FME Area should be clean and in sound mechanical condition. Make sure there are no loose or damaged parts that could break or fall off during use. Examples include loose wire brush bristles, mushroomed chisel or punch heads, and metal tools with frayed insulation.

Items with removable parts, such as the end of a flashlight, can sometimes be secured with duct tape. Items designed to separate during use, such as socket wrenches and drill bits, should be logged as separate items by the FME monitor.
Use the Right Lanyard

The lanyard length should be only as long as necessary. This will reduce the dropping distance and limit the possibility of the dropped item causing damage.

Remember that lanyards are a back-up method for preventing loss of materials. Do not suspend items by their lanyards. Never use power cords or air hoses as lanyards.
Some of these tools are in poor repair and should not be brought into an FME Area. Identify those tools by clicking on them.
Using Protective Covers

An important tool in creating a fail-safe environment is to cover or block equipment openings. There is a variety of devices for this purpose. They are usually brightly colored for easy recognition, and are located in carts, cabinets, and bins throughout the station.

Select each item below to learn more.

Access Covers

Pipe Bladders

Tents
Using Protective Covers

Access covers and other external closure devices prevent foreign material from entering equipment through an opening. All systems should be kept covered whenever possible. Exceptions to this are when maintenance, testing, or inspection require the opening to be uncovered.

Covers should be clean, sturdy, and free from debris. They should not cause FM to enter the system during installation or removal. Make sure they are fitted and secured properly so they can not be moved or become FM themselves. Do not use clear plastic as a cover, especially if it might enter a water-filled system.

If a cover is located where personnel may walk, it should be strong enough to support a person's weight or be clearly marked "No Step" (or similar wording).

Access Covers
Pipe Bladders
Tents
Using Protective Covers

Pipe bladders are generally internal blocking devices, such as inserted plugs, designed to seal pipes to isolate the equipment. They limit the distance that FM can travel if it enters equipment.

Pipe bladders must be tethered externally to equipment. This prevents losing them into the system and provides a visible warning about what is in the system.

These devices can be hard to clean when installed in vertical pipes, because the FM falls into the crevice between the pipe and the bladder. A wedge of foam around the interior pipe wall can help.

Pressure or vacuum sometimes builds up behind pipe bladders. Use a sturdy tether to keep them from dislodging, and always be very careful when removing them.

Access Covers
Pipe Bladders
Tents
A tent completely encloses a work area or an entire FME Area. It protects the open equipment from FM that might be in the general area.

This can include things like dust or debris from adjacent maintenance activities or from overhead sources such as cranes, gratings, walkways, vents, and drainpipes.

- Access Covers
- Pipe Bladders
- Tents
Click on the three locations that need FME covers in this photo.
Removing Protective Devices

Before removing an installed FME device, thoroughly inspect it to make sure that no FM has built up on or around it. Clean the device and the surrounding area to prevent Foreign Material from entering the equipment. After removing the FME device, document its removal in the FME log.

In the photo at left, the work area should be cleaned before removing the FME device to ensure that no debris enters the component.
Controlling the Use of Transparent Materials

Transparent materials, if they become Foreign Material, can be extremely difficult to find, especially in water. Do not use transparent materials, such as visors, clear plastics, and tubing, within an FME Area.

The only exception to this should be if the items are conspicuously marked or colored, such as red or yellow plastic.
Fuel Handling Equipment

Special care is needed when work is done over or near the spent fuel pool, refueling pool, or reactor cavity (such as on the refueling crane or refueling machine). Remember that the FME Boundary extends up and down into areas overhead and below. Do not lean over handrails that are being used as FME Boundaries.

Very strict FME controls should be used for work in these areas. When working directly above one of these areas, use a catch device such as netting or sheeting to catch dropped items.
It Happens when You Least Expect It

During a pre-dive survey of the spent fuel pool at one station, the surveyor accidentally bumped his radio pack against the handrail. Because the radio's battery pack was not taped, it fell into the pool.

At another station, workers were using a punch device to shear off corners of control rod blades. When a piece of the punching mechanism dislodged, it fell into the Spent Fuel Pool along with pieces of the control rod blade. This could have been prevented using FME techniques to catch the pieces.

Both of these problems cost time, money, and radiation exposure to fix.
Logging Items Into the FME Area

One way to ensure that FM doesn’t make its way into a system is to make sure that everything going into the FME Area is accounted for. This is done with material accountability logs.

**Material accountability logs** should contain enough information to ensure accountability of tools and equipment. Be as specific as possible (“1/2-inch combination wrench with lanyard”). Items that are damaged or have missing parts could result in questionable accountability. This is another good reason to use only tools in good repair. Items designed to separate during use, such as socket wrenches and drill bits, should be logged as separate items. Consumable items such as tape and rags should also be carefully accounted for.

A good practice is to occasionally take inventory of the area and then check the inventory against the log.
Poor Logging Techniques Cost Big

During the start up of a reactor after a planned outage, plant operators noticed excessive banging in some of the equipment. The unit was shut down and the cause was discovered. A piece of hardware used to hold an interior door open during maintenance had been left inside. Poor logging techniques contributed to the hardware being missed during closeout.

The outage was extended 30 days to investigate and repair the damage, at a cost to the company of about 30 MILLION DOLLARS.
Protecting Parts and Equipment During Transportation

FME controls are important even when parts and materials are in transit to or from the work site.

At a station in the mid-west, two hex nuts became wedged in a pressure control valve spring while the valve was being moved for repair. Later, the valve would not work properly, and operators had to control pressure manually. The valve had to be reworked to fix the problem.
Warehouse Storage

For materials stored in the warehouse, cover all openings that are vulnerable to FMI. Make sure these openings remain covered when moving parts to the work site. Once at the work site, all materials should be inspected for FM and cleaned if necessary before bringing them into the FME Area.

Likewise, some equipment may be removed from the FME Area for repair or calibration. Seal these items properly to prevent FMI during transportation.

The pictures at right show improper FME storage. Click on each picture to see the proper FME controls for equipment stored in the warehouse.
Warehouse Storage

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Likewise, some equipment may be removed from the FME Area for repair or calibration. Seal these items properly to prevent FMI during transportation.

The pictures at right show improper FME storage. Click on each picture to see the proper FME controls for equipment stored in the warehouse.
The Maintenance Shop

In most cases, parts and equipment that are in the maintenance shop for repair or calibration will eventually be returned to service in the plant. So be sure to exercise the same FME precautions in the shop that you would on the job site. Attention to housekeeping and cleanliness will prevent FM from sneaking into plant systems when the parts and equipment leave the shop and are returned to service.

*In the photo at right, click on the FME hazard.*
Let's Review

Information entered in material accountability logs should

- include manufacturer's part numbers
- be as detailed and specific as possible
- include only small things like hardware and hand tools
- be retained for three years as legal documents
Welcome to the menu page.

Please make a selection from the menu at right.

A GOLD star will appear when you complete each topic.

A GRAY star indicates that section is in progress. You must complete all the topics to receive credit for this course.

- Introduction
- FME Areas
- Responsibilities
- FME Work Practices
- Special FME Considerations
- Closeout and Inspections
Objectives

- Describe the role of Human Performance tools in FME.
- Describe precautions to take when operating a crane near FME areas.
- Explain the potential effects of FME controls on plant configuration.
- Identify what actions to take when the FME plan changes.
- Explain the proper response to a loss of FME control.
Using Human Performance Tools

Because the focus of FME is prevention, it is important to use human performance tools (techniques to prevent errors). Many of the tools are applicable, such as peer checks, questioning attitude, pre-job briefs, and procedure adherence. But the most important is self-checking.

Self-checking is a deliberate action that focuses your mind on an immediate task. The technique includes reviewing the intended action and expected responses before beginning a task, and then comparing the actual response with what was expected when the task is completed.
The STAR Technique for Self-Checking

There are many conditions that should prompt you to self-check using the STAR technique.

- Routine but critical tasks
- Time pressure
- Unable to remember
- A repetitive or boring task
- Distraction
- A feeling that something is not right
- Tired or fatigued
- The first time a task is performed

STOP and focus on your task objective.
THINK about what will happen when you act
ACT without losing contact with the component
REVIEW to verify that you achieved the expected results.
Using a Crane Over an FME Area

Foreign Material can fall from items being lifted by a crane. Check for loose parts, paint chips, or debris on items being lifted over an FME Area. Inspect cranes and other lifting equipment for potential FM before moving them over FME areas. Always consider the best lift path to minimize the likelihood of Foreign Material Intrusion.
Effects of FME Controls on Plant Configuration

FME activities may affect the configuration of other systems or equipment in the plant. For example, a water storage tank at a northeast station collapsed from the vacuum created when two open valve flanges were taped with plastic sheeting.

When planning FME controls, consider the possible dangers that might result from closing off ventilation routes when fitting covers, plugs, caps, or seals to tanks, vessels, or other structures. Possible dangers include the following:

- Creating a confined space that could reduce oxygen or collect harmful gasses or fumes
- Damage to equipment
- Implosion of sealed vessels (such as storage tanks)
- Impaired cooling system efficiency

For example, a condenser hotwell must be ventilated at the manway opening. Instead of covering it with plastic, use a fine mesh screen as shown in this photo.
Changes in the FME Plan

Occasionally, conditions on the job may change in such a way that some of the FME requirements in the work package become impractical or insufficient. In such cases, contact your supervisor to approve any necessary changes to the FME plan.

Be sure to document these changes. Include the time and date, a brief description of the change and the basis for it, and the name of the supervisor who reviewed and approved the change.
Loss of FME Control

When any of the following conditions exist, it should be assumed that FME control has been lost:

- Unexpected FM is found inside equipment when it is first opened.
- Material that is not immediately and safely retrievable is dropped into a system.
- Internal barriers fail or external covers are damaged or missing while the area has been left unattended.
- FM is found in an open-air system, such as the spent fuel pool or open tanks.
- Inspection of components reveals broken or missing parts just before installation or just after removal.
- A discrepancy is found in the control logs.
Recovering from Loss of FME Control

When FME control has been lost, stop work and secure the system or component so that it is safe. Notify your supervisor, who will direct the development of a recovery plan. If the system is in service at the time, also notify the control room. Then document the incident in the appropriate station reporting program.

ANYONE can stop work for loss of FME control at ANY TIME
Let's Review

Which of the following is a potential effect of FME controls on plant configuration?

- creation of a confined space that could deplete oxygen or accumulate hazardous products
- impaired cooling system efficiency
- damage to equipment
- all answers are correct
Let's Review

Who has the authority to stop work if FME control is lost?

- anyone
- only a supervisor
- only a quality control inspector
- only the Foreign Material Exclusion Monitor
Welcome to the menu page.

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Objective

- Describe proper closeout and inspection processes.
Closeout of the FME Area

When work is complete and the equipment is ready to be closed for return to service, clean the area as necessary to prevent FM from entering the system. Then remove and account for all FME devices that were installed. Be very careful when removing internal closure devices such as plugs or bladders because pressure can sometimes build up behind them.

After cleaning the area and removing any FME devices, conduct the As-Left inspection before reassembly to verify that the equipment is free of FM. This process should be conducted every time a system or component is reassembled for return to service – even temporarily.
FMI Can Happen Right Up to the End

The pictures to the right show the result of an incomplete inspection prior to reassembling a safety relief valve. Poor cleanup allowed some debris to slip between the mating surface of the SRV body and pilot. The debris was a small piece of grinding wheel, which caused the SRV to fail a leak test.

Before bolting parts together, remove all loose debris from the surrounding areas. Clean and inspect the mating surfaces.
Account for Everything

All materials, including FME devices, should be accounted for before final reassembly (closure) of the equipment. If any material cannot be accounted for, the supervisor should be notified.

During startup after a refueling outage, a station had to shut down its new reactor pump because a bearing overheated. The cause was a two-inch FME pipe cap that had been left in the system, blocking the component cooling water line. This cost time and money for rework, and affected plant reliability and safety.

The closure inspection must be performed and documented by trained and qualified workers. These individuals witness the closure of the equipment until there is no possibility of FMI. They also verify that appropriate cleanliness requirements are met.
Remove and Account for All Materials During Closeout

When the work is complete, all tools and materials are removed from the FME Area and nearby areas.

The control logs are carefully checked to make sure everything that went in has been taken out. FME Area boundaries are removed and the area is restored to its original condition or better.

Dispose of all consumable items removed from the FME Area and properly store reusable FME devices.
The FME Area below is ready for closeout - or is it? Find the three items that still need to be removed from the FME Area before it is ready to return to service.
Let's Review

When open equipment in an FME Area is being returned to service, even temporarily, it should be inspected for Foreign Material before it is reassembled.

☐ True

☐ False
Let's Review

What should be done before an FME Area is returned to service?

- Reconcile the material accountability logs to account for all materials.
- Return FME devices to their proper storage location.
- Restore the area to its original condition or better.
- All answers are correct.
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CONGRATULATIONS! YOU'RE DONE.
Select the "Exit" button to exit the course and receive credit for completion.