Navy Crane Center

NAVFAC P-307 Training

RIGGING GEAR INSPECTION
Web Based Training Student Guide

NCC-RGI-02

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MARKING AND RECORD REQUIREMENTS

NAVFAC P-307 SECTION 14
Let’s look at the section of NAVFAC P-307 that deals with rigging, Section 14. Section 14 provides administrative and technical requirements for inspection, testing, certification, alteration, repair, operation, and use of rigging gear. These requirements help ensure the rigging gear you use is safe. When followed, these requirements help ensure optimum service life of the gear. These requirements apply to Navy owned gear and to contractor owned gear used with Navy owned cranes.

THE TEST AND INSPECTION PROGRAM
P-307 requires each activity to establish a program that includes initial visual inspection and load test of all equipment and markings, pre-use inspections before equipment is used, documented periodic inspections of all equipment, and documented periodic load tests of certain equipment.

WHY TEST AND INSPECTION?
Why do we need a test and inspection program? The primary goal is to prevent personnel injury! The test and inspection program is designed to identify sub-standard, defective, damaged, or worn equipment, and remove unsafe equipment from service.

COVERED EQUIPMENT
Test and inspection requirements apply to the following equipment used in weight handling operations: rigging hardware such as shackles, links and rings, swivels, eye bolts, swivel hoist rings, turnbuckles, and hooks. These requirements also apply to slings including chain slings, wire rope slings, metal mesh slings, synthetic web slings, synthetic rope slings and synthetic round slings. These requirements also apply to crane structures without permanently mounted hoists.
COVERED EQUIPMENT
Equipment covered includes manually operated hoists as identified in ASME B30.16 and B30.21 which include chain hoists and lever operated hoists. Equipment covered also includes miscellaneous equipment, including below the hook lifting devices as identified in ASME B30.20, such as spreader beams, plate clamps, magnet lifters, pallet lifters, and tongs.

EQUIPMENT NOT COVERED
Equipment not covered includes ordnance equipment, which falls under NAVSEA OP-5, original equipment manufacturer or OEM installed welded lift lugs, threaded holes and bolt-on pads, and OEM provided rigging gear used for limited lifts such as off-loading, re-loading, initial storage, and shipment.

EQUIPMENT MARKINGS
Markings on each piece of equipment are the most apparent way for you, the user, to know the requirements of NAVFAC P-307 have been met. Each piece of equipment must be clearly marked, tagged or engraved with the rated load of the equipment and indication of the re-inspection due date. Markings must be done in a manner that will not affect the strength of the component. Vibra-etch methods and low stress dot faced stamps are generally acceptable ways of marking equipment. Contact the OEM for guidance on where and how to mark.

SPECIAL ROUNDSLING MARKINGS
NAVFAC P-307 has additional requirements for alternate yarn roundslings. Alternate yarn roundslings are roundslings made from yarns other than nylon or polyester. The certificate of proof test must include the diameter of the pin used for the proof test. This will be the minimum diameter over which the sling may be used. The sling must be marked with the minimum allowable pin diameter.
SPECIFIC USE ENDLESS WIRE ROPE SLING MARKINGS
In specific applications where endless wire rope slings are designed for a particular use, they shall be marked to indicate the pin diameter used to determine the rated load.

MARKINGS ON CHAIN SLINGS
In accordance with CFR 29 1915.112 and CFR 29 1917.42 chain slings used in ship repair or cargo transfer require quarterly periodic inspections and must be marked to show the month they were inspected.

MARKINGS ON LASHING
Lashing must be marked to identify it to the spool or reel from which it came. The rated load must be marked on each piece as well as the re-inspection due date.

MARKINGS ON BELOW THE HOOK LIFTING DEVICES
Any below the hook lifting device weighing more than 100 pounds must have the weight clearly marked on it.

MULTIPLE PART EQUIPMENT
Some rigging gear has multiple parts that can be disassembled. To help avoid mismatching parts, all individual components of equipment such as shackles and pins must be identified to each other. Matching ID marks are needed on the primary and subordinate parts.
Markings on Multi-leg Sling Assemblies

Multi-leg slings assemblies shall be marked with the rated load of each leg, the rated load of the entire assembly, and the sling angle upon which the rated load is based.

WLL MARKINGS FOR MULTI-PART SLINGS

NAVFAC P-307 requires that multi-part braided slings must have the OEM's marking re-marked at 70% of the OEM's rated load unless destructive tests are conducted on sample slings. The documentation is reviewed by the Navy Crane Center. So, there are many additional markings that may be required for different equipment. Not only do these markings have to be present, they must be legible.

HARD TO READ OR MISSING MARKINGS

Sometimes markings become hard to read due to wear or they may even be removed during a repair process. Replace markings that are hard to read or have been removed. Remember, all rigging equipment must be marked.

REQUIRED RECORDS

Equipment markings should link the piece of equipment to its test and inspection records. NAVFAC P-307 requires documentation of tests and inspections. Records are the auditable proof that equipment has been tested and inspected and provide a basis for ongoing evaluation of the equipment. The latest test and inspection record will be retained on file at the activity. Computer generated files are acceptable if they identify the individual components and inspection results.
RECORDS MUST INCLUDE
NAVFAC P-307 requires that the records include identification of individual components, latest test and inspection results, and dates of inspections and tests. There are many ways to identify the equipment to the records.

IDENTIFYING GEAR TO ITS RECORD
A unique identification number may be used to identify the equipment to its record. The ID number can be as simple or complex as you need it to be. A simple method might be to use a letter designator that represents a particular type of gear followed by a serialized number. For example, “S” could represent shackles. If you have 50 shackles they could each be individually identified S1, S2, S3, etc. Mark the equipment ID number on the gear. Write the ID number on the record. Now the gear has identifiable records!

This is an example of how the gear is marked at one Naval Shipyard. This is just one example of how an activity could choose to identify individual components to their records. This example reflects a fairly complex system that may be useful for activities who own multiple groups of equipment that need to be segregated. In this example, the unique identification number is used to identify three different things. The first number “98” identifies which shop, group, or code owns the equipment. Secondly, “P28” identifies the specific piece of gear with a serialized number. This particular number indicates that it was the 28th sling manufactured or certified on a specific day. The number 94-350 identifies the day it was manufactured or certified, 94 being the year 1994, 350 being the Julian date. No matter what method you use, there is important information that should be included in the gears records.
INSPECTION

TYPES OF INSPECTIONS
There are two types of required inspections, pre-use and periodic. The pre-use inspection is performed prior to use. No documentation is required for pre-use inspections. The periodic inspection is a comprehensive, documented inspection, performed on a schedule.

PRE-USE INSPECTION
All equipment must be inspected prior to each use. The pre-use inspection ensures the equipment is not damaged or worn beyond allowable limits. The inspector must verify the rated load of the equipment and ensure the markings are legible. If the inspection due date has passed, the equipment must not be used. Remove any gear from service that fails inspection.

PERIODIC INSPECTION
Periodic inspections must be done by a qualified person. If inspection reveals that the equipment has accumulated damage or is worn beyond the allowable limits it must be removed from service. Records must be kept on file for all periodic inspections. Inspection records provide a basis for evaluation, and provide the audit trail proving the equipment is in a test and inspection program. The inspection frequency varies depending on the type of equipment. See table 14-1 of NAVFAC P-307.

ANNUAL INSPECTION
Periodic inspections are required every year for slings, lashing, hoists, equalizers, load indicating devices, container spreaders, personnel platforms, cranes integral to larger machine systems, and below the hook lifting devices.
**BIENNIAL INSPECTION**
Periodic inspections are required every 2 years for rigging hardware such as beam clamps, tackle blocks, snatch blocks and wire rope blocks. Crane structures without permanent hoists are also included, as are: eye bolts, eye nuts, hook, links and rings, portable A-frames, portable gantries, portable floor cranes, shackles, swivels, swivel hoist rings and turnbuckles.

**INPECTION EVERY 3 MONTHS**
In addition to the annual inspection noted previously, OSHA requires a periodic inspection every three months for chain slings used in ship repair and cargo transfer.

**SLING REJECTION CRITERIA - KNOTS**
A knot in any part of a sling is cause for rejection.

**INSPECTING CHAIN SLINGS**
Chain slings used for overhead lifting must be fabricated from chain that is grade 80 or 100. Links are randomly marked by the manufacturer with 8, 80, or 800 for grade 80 chain, and 10, 100, or 1000 for grade 100 chain.
**INSPECTING CHAIN SLINGS**

Chain slings are generally very tough and durable and consequently they tend to get a lot of hard use. Carefully inspect each link and end attachment; including master links and coupling links. Nicks and cracks may be removed by grinding. Measure the link or component after grinding. Rejection is required if the defect cannot be removed or if any part of the link diameter is below the required minimum. Look for deformation such as twisted, bent, stretched links, or broken welds.

**CHAIN LINK WEAR**

Remove the sling from service if the thickness is below the value shown in NAVFAC P-307.

**CHAIN LINK STRETCH**

Chain links stretch when they are overloaded. Worn chain links will also cause the sling length to increase. Measure the length of each sling leg and look for increased chain length that may indicate overloading or link wear.

**INSPECT HAMMER LINK**

Inspect hammer links carefully. Make sure the keeper pin is not loose or protruding.
WIRE ROPE SLING REJECTION CRITERIA
Inspect wire rope slings along the entire length of the sling including splices, end attachments, and fittings. Look for permanent distortion such as kinked, crushed, or birdcaged areas.

WIRE ROPE SLING REJECTION CRITERIA
Look for core protrusion in-between the strands of the wire rope. Core protrusion is indicative of structural failure within the wire rope. The core should not be visible in straight runs. However, when a wire rope is bent, you will be able to see the core; this is not core protrusion. Fiber core wire rope slings may sometimes protrude between the strands in the end of an eye, opposite the bearing point; this too is not core protrusion.

WIRE ROPE SLING REJECTION CRITERIA
Look for signs of heat damage such as discoloration and other more obvious signs as shown here.

WIRE ROPE SLING REJECTION CRITERIA
Look for severe corrosion or pitting of the wires or any condition that would cause loss of wire rope strength.

MEASURING WIRE ROPE
When measuring wire rope sling diameter with calipers, make sure you place the caliper on the crowns of the wire strands. Do not place the caliper across the flats or valleys of the strands.
**Broken Wires**

Do not run your bare hand along the wire rope to detect broken wires! Bend the sling while watching for broken inside wires. Bending will open the area between the two ends and expose a broken wire making it easy to detect. Broken wire rejection criteria is based on a section of the wire determined by its “lay length”. Lay length is the linear distance along the wire rope in which a strand makes one complete turn around the rope's center.

**Strand Laid Wire Rope Slings**

Single part and strand laid wire rope slings must be removed from service if inspection reveals any of the following criteria, ten randomly distributed broken wires in one lay length, five broken wires in one strand in one lay length or two broken wires within one lay length of the end connection.

**Braided Wire Rope Slings Rejection Criteria**

For braided wire rope slings with less than eight parts, reject slings with 20 randomly distributed broken wires in one rope lay length, or one completely broken strand. For braided wire rope slings with eight parts or more, reject slings with 40 randomly distributed broken wires in one rope lay length or one completely broken strand.

**Cable Laid Wire Rope Slings**

Cable laid wire rope slings must be removed from service if inspection reveals, 20 randomly distributed broken wires in one rope lay length, or one completely broken strand.

**Wire Rope End Fittings**

When inspecting slings with end fittings, ensure the fitting is not cracked, deformed or loose. Make sure the wire rope in the fitting is not corroded. Inspect the end attachment for wear that exceeds 10% of the OEM's nominal socket dimension or 5% of the socket pin diameter. When inspecting slings with speltered sockets, the wire should not have any axial or lateral movement.
**METAL MESH SLINGS**
Inspect the entire length of metal mesh slings including welds, end attachments, and fittings. Remove the sling from service if inspection reveals a broken wire in any part of the mesh, a broken weld or broken brazed joint along the sling edge, reduction in wire diameter of 25% due to abrasion or 15% due to corrosion, lack of flexibility due to distortion of the mesh or any cracks in the end fitting.

**REMOVE FROM SERVICE**
Remove the sling from service if the eye openings in the end fitting are increased by more than 10%, or if there is a reduction of 15% of the original cross sectional area at any point around the hook opening of the end fitting.

**SYNTHETIC SLING REJECTION CRITERIA**
Never use synthetic slings with exposed core warning yarns. Do not rely on core warning yarns to indicate damage, as not all manufacturers use them and damage can reach rejection limits without exposing core yarns.

**SYNTHETIC SLING REJECTION CRITERIA**
Other damage that would require a synthetic sling to be removed from service includes heat or chemical damage, punctures, cuts, and variations in size, thickness or roundness of the sling.
**Synthetic Sling Rejection Criteria**
Look for broken or damaged stitches or splices. The stitching holds the sling together. Check it carefully.

**Synthetic Sling Rejection Criteria**
Look for damage caused by prolonged exposure to sunlight, which can result in discoloration, fading or roughness. Look for cracked, distorted, broken, or excessively worn, pitted, or corroded end fittings. Also look for knots or indications the sling has been knotted. If you find evidence that a sling has been knotted, remove it from service.

**Synthetic Rope Sling Removal Criteria**
Remove from service if considerable fiber or filament breakage is found along the line where adjacent strands meet. Light fuzzing is acceptable. Look for powder or particles of broken filaments or fibers inside the rope between the strands. Twist or pry the rope open for inspection. Inspect filaments or fibers for weakness, brittleness, or variations in the size or roundness of the strands.

**Synthetic Round Sling Removal Criteria**
Remove the sling from service if inspection reveals holes, tears and snags in the cover, broken or worn stitching, embedded particles, exposure of any core yarns, bumps, bulges, or irregularities. A knot in the yarn where the cover is joined is acceptable.
TYPES OF HARDWARE DAMAGE
When inspecting rigging hardware look for corrosion or severe pitting that would leave an orange peel effect when cleaned. Slight surface rust is okay. Inspect for wear, cracks, nicks, gouges, deformation, or distortion. Distortion may include elongation, peening, or heat damage.

AREAS TO INSPECT FOR HARDWARE DAMAGE
Inspect the whole body of the hardware, but be particularly vigilant when inspecting the bearing surfaces for wear and distortion. Pay particular attention to the bearing surfaces since this is where the load is applied and will often show tell-tale signs of overload or abuse; just as the flattened area indicates on this picture.

10% WEAR REDUCTION
Remove shackle bows and welded links, from service when wear exceeds 10% of the nominal diameter shown in federal specification RR-C-271. For shackle sizes not shown in federal specification RR-C-271, the OEM’s listed nominal dimensions will be used. Remove hooks from service when wear exceeds 10% of OEM’s nominal dimensions.

5% WEAR REDUCTION
Remove weldless links, shackle pins, and swivels, from service when wear exceeds 5% of the nominal diameter shown in federal specification RR-C-271. For sizes not shown in federal specification RR-C-271, the OEM’s listed nominal dimensions shall be used. Remove eyebolts when wear exceeds 5% of the OEM’s nominal eye section diameter. Remove turnbuckles when end-fitting wear exceeds 5% of the OEM's nominal dimensions. Remove swivel hoist rings when wear exceeds 5% of the OEM's minimum dimensions.
AREAS TO INSPECT FOR HARDWARE DAMAGE
Threaded shanks must be inspected carefully before use or load testing. When using gear with threaded shanks such as eyebolts, hoist rings, etc., inspect the shank carefully for bends, twists, or damaged threads.

INSPECT MOVING PARTS
Some hardware has moving parts such as hoist rings and turnbuckles. Ensure that all moving parts move freely. Hoist ring bases should swivel 360° and the bail should pivot at least 180°.

TACKLE BLOCKS
Tackle blocks shall be removed from service if inspection reveals distortion, cracks in the housing or sheaves, damaged sheaves, binding, abnormal sheave play, or any damage that may cause doubt as to the strength of the unit.

BELOW THE HOOK LIFTING DEVICES
Below the hook lifting devices and container spreaders shall be inspected in accordance with ASME B30.20 and OEM recommendations. Always read and follow the information provided by the OEM.

HOISTS, CRANES, A-FRAMES, GANTRIES
Chain hoists and portable hoists shall be inspected in accordance with: ASME B30.16 and OEM recommendations. Lever operated hoists shall be inspected in accordance with ASME B30.21 and OEM recommendations. Other equipment shall be inspected in accordance with applicable ASME B30 criteria and/or OEM recommendations.
PORTABLE LOAD INDICATING DEVICES
Check for visible damage and any other attributes listed by the OEM. Portable load indicating devices shall only be used in the range that ensures the proper design factor. Ensure they are marked or tagged to indicate the reduced maximum rated load, if required.

REPAIRS AND ALTERATIONS
When minor damage, such as nicks or cracks are found, it may be possible to remove the defect rather than replacing the gear. Repairs must be performed in accordance with OEM or engineering instructions. Alterations must be approved by the activity engineering organization. Re-inspection and load test of the repaired or altered equipment shall be performed prior to returning to service.

AUTHORIZED HARDWARE REPAIR
Grinding to remove defects is the only method authorized to repair rigging gear. Heat or welding is not permitted to correct defects. And no attempt shall be made to straighten bent or twisted rigging gear. Grinding shall follow the contour of the piece blending with a maximum 1 to 3 taper. The component dimensions after grinding must be within the wear limits for the piece being repaired. If the after-grinding dimensions exceed the wear limits specified by the OEM or NAVFAC P-307, the component must be removed from service. Removal of defects as specified will not require a load test.

NON DESTRUCTIVE TEST
Removal of cracks must be verified by non-destructive testing before the hardware can be returned to service.
TEST REQUIREMENTS

LOAD TEST TYPES
There are two types of load tests described in NAVFAC P-307. The first is a static load test. In a static test the load is held for a specified amount of time to determine if the equipment will hold the load. The second test is a dynamic test. In a dynamic test the load is applied and the equipment is operated through a complete cycle of all its moving parts. Dynamic tests are performed under load to insure the equipment operates properly, to check brake mechanisms, and to observe for indications of improper operation such as unusual noises or binding.

STATIC TESTS
Load tests ensure that the equipment will operate safely within its rated load and design function. All covered equipment must be static tested with the equipment holding the test load for a minimum of 2 minutes. Hoist, crane, and crane structure static tests must be held for 10 minutes. No permanent deformation should be found.

DYNAMIC TESTS
Equipment with moving parts requires an additional test. Hoists, trolleys, and other moving machinery are required to have a dynamic test in addition to the static test. They must lift, or travel, through at least one revolution of all moving parts with the test load applied.

INITIAL LOAD TEST
Each piece of covered equipment must have an initial load test. A manufacturer’s certificate of proof test will satisfy this requirement as long as the proof load meets or exceeds the load specified in NAVFAC P-307. Certificates of proof tests for alternate yarn roundslings must include the diameter of the pin used during test. Any material other than nylon or polyester used to fabricate a roundsling is known as an alternate yarn.
DETERMINING TEST LOADS
To determine the correct test load, you will need to know the rated load of the equipment and the required test percentage. Load test percentages for rigging gear and related equipment can be found in Table 14-1 of NAVFAC P-307. Be sure to check the test load percentage for the type of gear you are testing as different types of gear are tested at different percentages.

TEST LOADS (+5% -0%)
The test load tolerance is plus 5% and minus 0%. The plus 5% provides a range to ensure the full test load is achieved without excessive overloading.

MINIMUM TEST LOAD
To find the minimum test load for a plate clamp with a rated load of 2,000 lbs. we must first find the required test load percentage in Table 14-1 of NAVFAC P-307. We see the plate clamps are tested at 125%, plus 5%, minus 0%. Multiply 2,000 pounds by 1.25. This equals 2,500 lbs. The test load must not be less than 2,500 lbs.

TEST LOAD TOLERANCE
Once the minimum test load is established we need to determine the load tolerance. Multiply the 2,500 lbs. minimum test load by 1.05. This equals 2,625 lbs, the maximum test load for this piece of equipment.

CONFLICTS WITH P-307 TEST LOADS
Where the OEM does not allow testing at the required test percentages, the OEM’s rated load will be used as the load test value.
**Rated Load Reduction**

For example, if we need to load test a plate clamp that has a rated load of 2,000 lbs. and the OEM does not allow overload testing, 2,000 lbs. will be used as the test load. Because the test load has been reduced we must also reduce the rated load. To find the reduced rated load divide the OEM’s rated load by the test load percentage. So we divide the OEM rated load of 2,000 lbs. by 1.25 and find the reduced rated load is 1,600 lbs. The item must be marked to show the new rated load.

**Conducting a Load Test**

When conducting load tests, wear the appropriate personal protective equipment and secure the area to keep personnel out of harm's way in case the equipment fails. Remember, you are exceeding the rated load of the gear. Be safe!

**Specific Requirements**

Many requirements are specific to the type of equipment being tested. Rigging assemblies must be tested with all of the parts together as a complete assembly. The components may not be used separately unless each component was individually tested to the requirements of NAVFAC P-307.

**Multiple Leg Slings**

When testing multiple leg slings the legs may be tested individually; or they may be tested two at a time with the legs 180° apart. Master links and master coupling links must be tested to the test load required for each individual sling leg multiplied by the number of sling legs. Activities may choose to size the master links assuming only two legs will carry the load. In that case the test load will be two times the test load of an individual leg.

**Lashing**

Lashing materials such as synthetic rope, wire rope, and webbing do not need to be individually tested if a sample has been tested and each piece is marked. A sample from each spool or reel must be tested and determined to have satisfactory breaking strength. OEM certification is acceptable. Each piece used for lashing must be inspected and marked.
ANNUAL LOAD TEST
A periodic load test must be conducted annually, or within 12 months prior to use on manual and powered hoists, magnetic and vacuum lifting devices, personnel platforms, plate clamps and cranes and hoists that are integral to larger machine systems.

CONTROLLED STORAGE EXCEPTION
The requirement for periodic load test within 12 months prior to use does not apply to manually operated portable hoists placed into an extended controlled storage condition. The hoist must be inspected, repaired if necessary, and initially load tested. It may then be placed in controlled storage and given a tracking number. A numbered metal locking band must be applied to the pull chain or operating lever to ensure the hoist cannot be operated. When the hoist is needed for use, it must be visually inspected for apparent damage or significant deterioration and operated prior to being issued. The inspection due date must then be marked on the hoist. This new inspection date cannot exceed one year from the date the hoist was put back into service.

LOAD TEST EVERY 2 YEARS
Crane structures without permanently attached hoists, as well as portable A-frames, portable gantries, and portable floor cranes, are required to be tested every 2 years.

RIGGING GEAR
All common rigging equipment like slings, shackles, hooks, rings, links, and eyebolts purchased after January 1998 require a onetime load test of 200%. A certificate of proof test from the equipment supplier satisfies this requirement. Certificates must be retained on file.

CONTAINER SPREADERS AND BELOW THE HOOK LIFTING DEVICES
Container spreaders and below the hook lifting devices shall be tested in accordance with Section 14 of NAVFAC P-307.
RIGGING GEAR INSPECTION EVALUATION

Student Name: _______________________________________________________________

Command/Activity/Organization: _________________________________________________

Instructor: ________________________________________ Date: _____________________

**Directions:** To assist in evaluating the effectiveness of this course, we would like your reaction to this class. **Do not rate questions you consider not applicable.**

<table>
<thead>
<tr>
<th>Please rate the following items:</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
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<td>Content of the course met your needs and expectations.</td>
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<td>Content was well organized.</td>
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<td>Exercises/skill practices were helpful.</td>
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<td>Training aids (slides, videos, etc) were used effectively.</td>
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<td>Instructor was knowledgeable and comfortable with the material.</td>
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<td>Instructor handled questions effectively.</td>
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<td>Instructor covered all topics completely.</td>
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<td>Probability that you will use ideas from the course in your work.</td>
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<td>Your opinion of the course.</td>
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<td>Your overall opinion of the training facilities.</td>
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What were the key strengths of the training? How could the training be improved? Other comments?
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List other training topics in which you are interested: __________________________
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**Note:** If you would like a staff member to follow up and discuss this training, please provide your phone number
___________________________________________________________________________