CHANCE®

TESTING HOT LINE TOOLS

IN COMPLIANCE WITH OSHA RULES AND REGULATIONS

HUBBELL®

OSHA RULES AND REGULATIONS published in the Federal Register address the work practices to be used during the operation and maintenance of electric power generation, transmission and distribution facilities.

Current regulations cover numerous aspects of line operation and maintenance. Live-line tools (hot sticks), including their design, operating condition and periodic testing, are governed by rigorous rules.

This article briefly summarizes those requirements. For a more extensive discussion of service and test procedures, see section beginning on page 4. For complete documentation and source information, the OSHA and Standard references cited there should be consulted.

Factory testing monitors leakage current and withstand strength at 50 kV per 6″ over full length. All Chance Epoxiglas® hot sticks are manufactured to ASTM requirements.

DESIGN

FRP (fiberglass-reinforced plastic) live-line tools must be designed and constructed to withstand 100,000 V per foot for five minutes. FRP tools that meet ASTM F711 Standard Specifications conform to this requirement.

Comments

ASTM Specification F711 was was originally published in 1981, and has been revised more than once since its inception. Hubbell Power Systems and all previous owners of the Chance® brand of FRP tools have had an active role in the development of this standard. Chance tools have been manufactured in conformance with this standard since its inception.

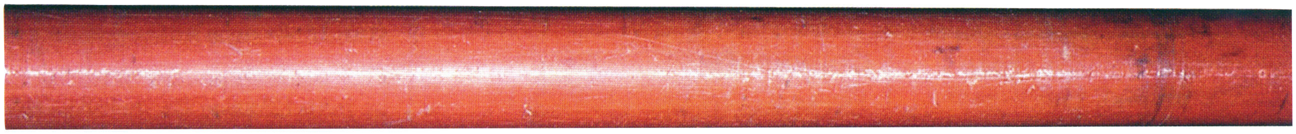
Chance® FRP tools manufactured prior to the initial writing of ASTM F711 were designed and manufactured under proprietary standards that meet the current ASTM requirements and which, in large measure, set the requirements which subsequently were adopted by ASTM.

CONDITION

Each live-line tool shall be wiped clean and visually inspected for defects before use each day. If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the tool is present after wiping, the tool shall be removed from service and examined and tested in a manner prescribed by OSHA before being returned to service.

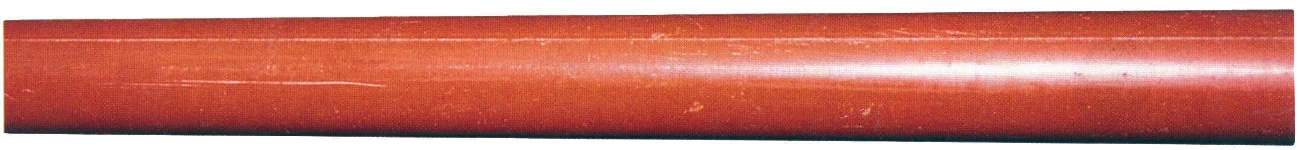
Comments

It has been long recommended that Chance® hot-line-tools be wiped with a silicone-impregnated cloth prior to daily use. Combined with the required inspection, these are common-sense safety measures which have been a standard practice of many utilities.



Typical used stick that will not pass the OSHA wet test even with a wax or silicone treatment. Complete refinishing is required to restore glossy surface and enable this tool to pass the OSHA wet test.

Tool as taken from utility service. This tool could not pass the OSHA wet test even after complete factory refinishing. Tools in this condition must be removed from service.



Used tool in basically good condition. With a wax or silicone wipe, this tool will pass the OSHA wet test and is satisfactory for service.

OSHA requires daily inspection and cleaning of hot sticks prior to work.

PERIODIC MAINTENANCE AND TESTING

Per OSHA, every two years live-line tools used for primary employee protection shall be removed from service for examination, cleaning, repair and testing. Also, anytime the daily wiping and inspection routine requires a tool to be removed from service, it must undergo the same examination, cleaning, repair and testing procedure that is required on a two-year basis for all hot-line tools.

All FRP tools must be electrically tested unless repair or refinishing has <u>not</u> been performed, and the employer can demonstrate that the tool has no defects that could cause it to fail in use.

TEST METHODS

When testing of tools is required under any of the circumstances listed above, the specific methods are described in the OSHA Rules and Regulations and in IEEE Standard 516.

FRP tools require a wet test at 75,000 Volts per foot for one minute. Tests must verify the tool's integrity along its entire working length.

An alternate Watts-loss test method that is performed at lower voltage (2,500 Volts minimum) is also acceptable. Either of these test methodologies require laboratory equipment and techniques.

Comments

Note that wet tests are never performed on wood tools. This is consistent with the long-held practice that wood tools should never be intentionally exposed to water under any circumstances.

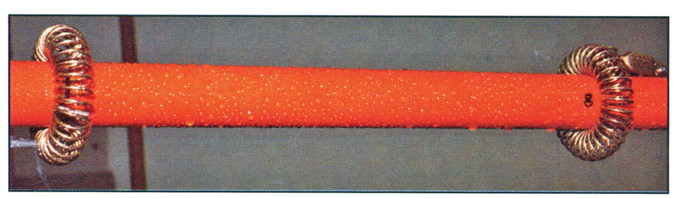
"Other tests that the employer can demonstrate are equivalent" are also allowed by the OSHA Rules and Regulations. The following section describes tests at Hubbell Power Systems to qualify one such alternate test as equivalent. This method also can be used to provide an enhanced verification of the tool's integrity in the daily use routine. It is a proven and practical field test that does not require laboratory equipment or techniques.

OSHA Regulations and the Chance® Hot Stick Tester

In response to the new OSHA regulations, Chance performed an extensive test series. Tests on new and used hot sticks compared the results using IEEE tests prescribed in the OSHA Regulations and the Chance Portable Hot Stick Tester. Wet tests were of particular interest because of the OSHA wet test requirements. The purpose was to determine the appropriate uses of the Chance Hot Stick Tester. Other objectives were to obtain a comparison between wet and dry tests and to determine the effectiveness of wax versus silicone oil. In 1995, Chance introduced a redesigned Wet/Dry Hot Stick Tester to test to the new standards [Cat. No. C4033178 (110 VAC) and Cat. No. C4033179 (230 VAC)].

Chance® hot-stick tester in laboratory use. This instrument is recommended by Chance as a field check (sticks tested dry) and as an alternate to the OSHA laboratory test (sticks tested wet).

To pass the OSHA wet test, water must bead up rather than wet out the surface. Wax or silicone will enhance this property if the surface is in satisfactory condition.



Typical laboratory arrangement per the OSHA test criteria with electrodes on a 1-foot section.

Hot-stick dielectric properties

A hot stick can become electrically unsafe because of either of two general conditions:

1. **Internal conductivity** can increase from moisture ingress, dielectric deterioration or internal structural changes. Significant loss of dielectric strength from these causes should not occur in a tool that is properly designed, manufactured, used, and stored. However, the numerous "ifs and unknowns" in the history of any tool preclude the assumption of a sound internal dielectric.

2. **Surface conductivity** can result from a combination of loss of gloss, wetting, and contamination. Deposits of surface contamination, especially in the presence of moisture, can render even the most perfect tool unsafe. Even surface moisture alone can render a tool unsafe if the surface is non-glossy to the extent that it allows the moisture to wet out the entire surface.

Thus, it is essential that the surface be both clean and glossy. The gloss prevents wet-out or sheeting of moisture that can cause conductivity. In this sense, moisture alone is a contaminant. The best procedure is to avoid the use of hot sticks in damp or rainy weather. If this not always possible, the best defense is a clean, glossy tool that will cause water to bead-up, rather than wet-out the surface.

Test specimens

Nine different hot sticks were used in the test series: Three were brand new and six were taken from long-term utility service. The latter six were selected because of their notably poor condition from a much larger pool of used tools. Surfaces had varying degrees of scratches, scarring, dents and local impact damage points typical of long, hard usage. The surfaces were discolored and dull, but all sticks appeared to be structurally undamaged. Two of the six used tools were prejudged to be unsuitable even to attempt refinishing. Three different diameters were represented: $1^1/_4$", $1^1/_2$" and 2". All were manufactured by Chance. The age of the six used tools could not be determined.

Test methods

Four test methods were used to compare their effectiveness:

- IEEE 516, paragraph 5.3 High-Potential Test Method (**dry**)
- Chance Hot Stick Tester (**dry**)
- IEEE 516, paragraph 5.3 High-Potential Test Method (**wet**)
- Chance Hot Stick Tester (**wet**)

All hot sticks were tested at intervals of 1 foot over their entire lengths. This produced five to eight tests per hot stick, depending on length. During the wet tests using the Chance Hot Stick Tester, it was found advantageous to rotate the hot stick 360 degrees at each test position to completely explore the surface condition. Wet tests were performed with demineralized water purchased in a local grocery. Conductivity of the water measured 3.0 micromho-cm at room temperature. Water was applied to the test specimens using a mist from a laundry-type spray bottle.

Test sequence/Surface preparation

All hot sticks were tested in a sequence designed to preserve the surface conditions before proceeding to the next stage of surface improvement. Surfaces of used tools progressed from the "as received" condition through cleaning, waxing or siliconing and, finally, complete refinishing. New tools proceeded through all test sequences with only a light wipe with a dry cloth prior to each test series.

Sequence A — As received

All tools were first tested as received, with only a light wipe with a dry cloth to remove any extraneous dust from storage. This is considered to represent the condition of last actual field use of the used tools. Dry tests preceded wet tests.

1 IEEE 516	75 kV	Dry
2 Chance® Portable Tester		Dry
3 IEEE 516	75 kV	Wet
4 Chance® Portable Tester		Wet

Sequence B — Solvent cleaned

The used tools were cleaned with a cloth wetted with Chance® Moisture Eater II hot-stick cleaner. The above test sequence was repeated.

Sequence C — Surface waxing or siliconing

After thorough drying to eliminate any residue moisture from the previous wet tests, one-half of each tool length was waxed with automotive carnauba wax and the other half was wiped with a Chance silicone-impregnated cloth specifically designed for hot sticks. Only the wet tests were performed following this treatment as it was now apparent that all dry tests would indicate "good."

Sequence D — Refinished surfaces

Finally, the used sticks were refinished per Chance specifications for hot-stick repairs. This consists of abrasive smoothing of the surface and refinishing with a clear epoxy coat. Only the wet tests followed this treatment.

Discussion

In performing wet tests, it is important to avoid over-wetting. The objective is to have the water either bead up on a glossy surface or wet-out a non-glossy tool. If too much water is sprayed on the tool, water will collect in a line of drops at the undersurface, producing a false rejection because of flashover or high leakage current. The technique we found successful was to thoroughly spray the test section with a mist applicator until drops just start to run down the surface.

In performing wet tests with the Chance Hot Stick Tester, certain techniques need to be noted:

a) The instrument should be lifted, not slid, from one test position to another. Sliding produces water streaks that can cause a false Reject indication.

b) The stick should be rotated under the instrument in each test position to more thoroughly test the entire surface of the tool.

Waxing with a good grade of wax or wiping with a silicone-impregnated cloth were judged to be basically equivalent in restoring the glossy, non-wetting nature of the surface. The silicone-oil wipe is preferred because it is a more practical daily procedure (one which Chance has long recommended) and it avoids an undesirable heavy wax build-up.

Test summary

243 individual tests compared the effectiveness of the IEEE 516 test methodology and the Chance® Wet/Dry Hot Stick Tester.

229, or 94 per cent, gave identical results. That is, both tests either accepted or rejected a particular section of a hot stick. 142 were accepted and 87 were rejected. This high rejection rate reflected the poor condition of the used hot sticks that were selected for the test series.

All of the rejections were from wet tests on the used sticks. No dry test ever rejected a used or new stick, and no wet test ever rejected a new stick. This indicates that all of the tested sticks were internally sound, with no significant loss of internal dielectric strength.

The poor surface condition of the used sticks was the cause of all the rejections. Of the two sticks that were prejudged to be unsuitable for refinishing, one did recover acceptable surface integrity from refinishing.

Of the 14 (6 per cent) individual test comparisons where the Chance Hot Stick Tester and the IEEE tests gave conflicting indications, the Chance Hot Stick Tester was slightly more discriminating. The Chance Hot Stick Tester rejected 11 of these 14; the IEEE test rejected 3. All of the 14 were in the transitional zone between pass/fail criteria.

Four of the eight IEEE-reject/Chance Hot Stick Tester-pass test results were judged to have resulted from too much water collection. With the encircling electrodes of the IEEE test this produced a flashover along the underside of the stick at or below 75 kV. Upon retest with slightly less water, these four passed.

Another mitigating factor where conflicting indications were given by the two test methods was the pass/fail criterion which we used. The IEEE Standard requires only that the dielectric/leakage current remain stable at full test voltage for one minute test duration. We also applied a more severe criterion that any current in excess of 200 microamps constituted a failure, even if it had stabilized. This reduced the number of disagreements from 14 to 12, or a 95% correlation.

Considering the conservatism that is built into the interpretation of both test methods, any of the tools which were in a transition zone such that one test indicated Pass while the other showed Reject would actually be safe in its tested condition. However, any such tool has obviously deteriorated to some degree and is a probable candidate for a clear Reject on a future test.

CONCLUSIONS

A hot stick must have either internal conductivity or a contaminated surface to fail a dry test. None of the test sticks ever failed a dry test, even though the used sticks were selected because of heavy scarring and general surface abuse.

Heavily scarred sticks consistently failed wet tests, even after cleaning and application of either wax or silicone oil.

Complete refinishing of heavily scarred sticks will restore surface integrity up to some limit of damage that is most easily determined by trial.

Surface wet-out when water is applied is evidence that the stick needs maintenance. Simple waxing or siliconing may suffice if the stick is in basically good condition. Complete refinishing will be required for scarred surfaces. Waxing or siliconing alone will not always enable a stick to pass a wet test.

When wet testing, over-application of water can cause a false indication of failure due to collection of water droplets along the bottom of the stick.

The IEEE test and the Chance Hot Stick Tester had an excellent correlation (94 per cent) of consistency. Of the 6 per cent of tests where the two techniques gave conflicting indications, the Chance Hot Stick Tester was slightly more critical (11 fail versus 3). All of these readings were in the transitional zone between acceptance and rejection where the stick had shown some deterioration, but did not yet represent a hazardous condition.

RECOMMENDATIONS

The following recommendations are made to assist utilities in the furtherance of safe hot-stick practices. We believe they are consistent with the new (1994) OSHA Rules and Regulations for hot-stick use.

a) The OSHA requirement that tools be wiped clean and visually inspected before use each day is best accomplished with a special silicone-impregnated cloth. This provides the right degree of texture for dirt removal with the application of silicone for water repellency (beading).

b) Though not required by OSHA, periodic field or shop testing with the Chance Hot Stick Tester (dry) gives further assurance that there is no defect or contamination that might adversely affect the insulating qualities and that would require removal of the tool from service for more extensive examination and testing.

c) Under the two-year OSHA Examination, Testing, Cleaning, and Repair requirements, for those tools that do not require refinishing but only cleaning and waxing, no further testing is required ". . . if the employer can demonstrate the tool has no defects that could cause it to fail in use."*
Hubbell Power Systems believes that the most practical and effective way to accomplish this is a visual inspection and use of the Chance Wet/Dry Hot Stick tester with the tool tested dry.

d) For those tools requiring repair or refinishing due to application of either the two-year rule or because of a condition found during the daily inspection, the OSHA Rules and Regulations require testing over the full length of the tool. Two alternatives are allowed:

1. Wet testing at 75,000 V/foot for 1 minute (fiberglass tools)
2. Other tests that the employer can demonstrate are equivalent. It is the belief and recommendation of Hubbell Power Systems, based on many years of experience in the use and testing of hot sticks, and based on the comparative tests presented in this paper, that the use of wet tests with the Chance Wet/Dry Hot Stick tester fulfills this equivalency for FRP tools. For wood tools, all tests should be performed dry.

*Note that this exception to further testing applies to only fiberglass tools, not wooden tools.
Never intentionally expose or apply water to a wood hot stick — for test reasons or any other purpose.

References

- Department of Labor, OSHA, 29 CFR part 1910; Federal Register, Vol. 59, No. 20, Jan. 31, 1994, Rules & Regulations.
- IEEE Standard 978-1984, Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools.
- ASTM F711-89, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube used in Live-Line Tools.

About Hubbell Power Systems:

BR09002E

Hubbell Power Systems (HPS) manufactures a wide variety of transmission, distribution, substation, OEM, underground and communications products used by utilities. HPS products are also used in the civil construction, transportation, gas and water industries. Our product line includes construction, switching and protection products, hot line tools, insulators, arresters, pole line hardware, cable accessories, test equipment, transformer bushings, connectors, grounding equipment and polymer precast enclosures and equipment pads.

Hubbell has a policy of continuous product improvement. Please visit hubbellpowersystems.com to confirm current design specifications.

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