

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON, D.C. 20555

September 26, 1996

NRC INFORMATION NOTICE 96-52: CRACKED INSERTION RODS ON TROXLER
MODEL 3400 SERIES PORTABLE MOISTURE
DENSITY GAUGES

Addressees

All U.S. Nuclear Regulatory Commission portable gauge licensees and vendors.

Purpose

NRC is issuing this information notice to alert addressees to the potential for cracks to develop in the insertion rod of Troxler model 3400 portable moisture density gauges. If not detected early, the cracks may propagate, eventually leading to complete failure of the insertion rod and release of the contained radioactive material. This notice provides information that users of these gauges may consider to avoid crack initiation and to detect existing cracks. It is expected that recipients will review the information for applicability to their licensed activities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action nor written response is required.

Description of Circumstances

NRC was notified of several incidents where the source cup of a Troxler model 3401 portable moisture density gauge separated from its insertion rod, releasing the contained, nominal 333 MBq (9.0 mCi), cesium-137, sealed source. One of the users of a failed gauge contacted the manufacturer and requested an examination of its failed gauge and all other Troxler gauges it possessed. The examination determined that the failure occurred in the vicinity of the weld joining the stainless steel insertion rod and source cup and that several other gauges in the user's possession were suspected of containing cracked rods/cups, as well. The manufacturer recommended that the user discontinue use of all gauges suspected of being damaged until further inspection.

Following examination of the user's gauges, the manufacturer initiated an inspection and testing program on model 3400 series gauges returned to it for disposal or repair that contained "unthreaded" (not joined with a threaded connection) source cups and insertion rods. This included only gauges with serial numbers less than 13301. The manufacturer only examined gauges with "unthreaded" rods/cups because all gauges that were reported as having cracks were this configuration. The manufacturer provided the following information and results from its investigation:

- 235 gauges that had been returned for repair and 75 gauges that had been returned for disposal were inspected.

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- Drop and bending tests were performed on the 75 gauges that had been returned for disposal to determine the force necessary to cause failure of the weld joint. Fatigue was not considered during the testing.
- Two of the 75 gauges returned for disposal were determined to contain a transverse crack on the insertion rod in the weld region.
- A number of the rod/cup welds of the 235 gauges returned for repair were determined to be "unusual," but none were determined to contain cracks.
- The manufacturer received a report of another gauge, not included in the investigation, whose rod/cup joint had also failed completely in the field, releasing the contained sealed source. The manufacturer suspected that the gauge had been abused during use, but the gauge was not available for the manufacturer to perform a full examination.

Based on the results of its investigation, the manufacturer concluded that weld failure is an unlikely event when the gauge is subjected to normal conditions of use and typical drop accident conditions. It also concluded that fatigue and thermal stresses would not be expected to have an adverse effect on the weld joint under normal conditions. However, there was no fatigue nor thermal testing during its investigation.

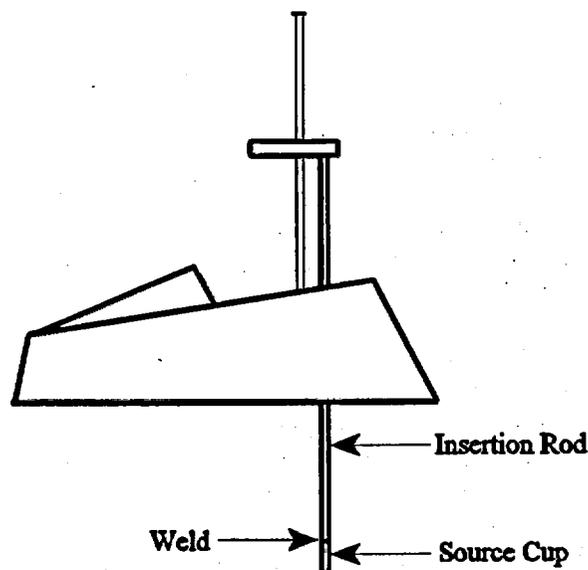
Concurrent with the manufacturer's investigation, NRC contracted an independent third-party testing facility to examine, in detail, the failed gauge, previously examined by the manufacturer, and four other of the user's model 3400 series gauges (three of which were suspected of also being damaged), and determine the root cause of the failure, if possible. This examination resulted in a number of conclusions and observations, including:

- The failure resulted from an initial crack in the weld region of the insertion rod that grew progressively until it failed completely in a brittle manner, releasing the contained sealed source.
- The initial transverse crack likely resulted from the insertion rod being subjected to a severe bending load (possibly an impact) not sufficient to cause catastrophic brittle failure.
- The initial crack propagated slowly due to repeated loads during use. The crack extended approximately 290° before the final brittle fracture.
- The region of crack initiation (the heat-affected zone around the weld) was very hard, but the weld was very soft. This differential in hardness was caused by material selection, joint configuration, and the welding procedure, and provided a stress concentration in the region around the weld. The stress concentration made the weld area more susceptible to crack initiation in a high-bending load condition.
- One of the other gauges received from the licensee was confirmed to contain a transverse crack in the region of the weld. Hardness testing indicated that this gauge also contained a soft weld and a high-hardness region surrounding the weld. In addition, the rod/cup was constructed using the same materials and processes as the failed gauge.

- The remaining three other gauges were undamaged, but had similar hardness characteristics as the failed gauge.
- All gauges received for testing contained "unthreaded" rods/cups and were constructed using the same materials and processes. The source cups on newer model 3400 series gauges (serial numbers above 13300) are threaded to the insertion rod before joining by welding.
- The weld configuration of the rod/cup connection is not optimum for its intended application, and provides a high stress concentration in the weld area. An alternate selection of materials and joint configuration, and a post-heat treatment may have reduced the high-hardness region, resulting in a lower stress concentration in the weld area.

Based on the above observations and testing performed, the third-party contractor concluded that all gauges manufactured in the same manner as the failed gauges would be susceptible to crack initiation when subjected to a severe bending load. In addition, the contractor concluded that a crack on this type of gauge would be expected to propagate slowly over time and could be easily detected visually, either by using a dye penetrant evaluation technique or by observing the weld area under magnification. The contractor's visual examination without dye penetrant or magnification indicated a potential crack in an insertion rod, that was subsequently determined to only be a surface feature. Therefore, visual examination should not be considered a reliable way to identify cracks.

The figure below shows the typical configuration of a Troxler model 3400 series gauge and the locations of the insertion rod, source cup, and weld:



Typical Model 3400 Series Gauge

In June 1996, Troxler issued a bulletin (attached) discussing the above incidents and the results of its investigation. The bulletin provided gauge users with three recommendations on how to reduce the likelihood of future source cup detachment incidents. These included:

1. Gauges should be used in accordance with the manufacturer's instructions found in the operator's manual. Under no circumstances should the insertion rod ever be driven or forced into the test material. A drill rod accessory is provided with the gauge to prepare a hole in the test material into which the rod is inserted. If the user purchases a used gauge that does not include the drill rod accessory, the user should contact the manufacturer to obtain a replacement drill rod.
2. Users should have the gauge and insertion rod inspected at least once every 5 years for unusual wear and tear.
3. Companies purchasing used gauges should require an inspection before purchase. Gauges involved in accidents should be inspected before further use.

Discussion

The aforementioned observations and investigations indicate that a gauge manufactured using the same materials, welding process, and rod/cup configuration as those identified as containing cracks would be expected to be susceptible to crack initiation in the weld region when placed in a high-bending load. Cracks in the weld region of the insertion rods would be expected to propagate over time, possibly leading to complete failure and release of the contained sealed source. However, before complete failure, a crack of this type should be identifiable by macroscopic visual examination or dye-penetrant testing. It is unknown whether crack initiation could occur under other conditions not discussed here nor considered during the testing performed by the manufacturer or the third-party contractor.

When used according to the manufacturer's instructions and recommended conditions of use, crack initiation would not be expected. Users of Troxler model 3400 series gauges, and other similar gauges, should always operate their devices in accordance with the manufacturer's instructions and under the recommended conditions of use, and should never place the insertion rod in a bending-load condition. The bending-load force necessary to initiate a crack was not determined during either the manufacturer's or the third-party contractor's investigations. Therefore, bending-loads on the insertion rod, other than those encountered during normal use, should be avoided.

The manufacturer has changed the design, materials, and manufacturing process for model 3400 series gauges several times since their introduction. The manufacturer's and third-party contractor's investigations were limited to model 3400 series gauges with serial numbers less than 13301 (gauges with "unthreaded" rods/cups and the same materials and methods of construction). Therefore, the susceptibility to crack initiation of gauges with "threaded" rods/cups or with other materials of construction and welding processes (models with serial numbers greater than 13300) is not known. However, all failed gauges to date have had serial numbers less than 13301. A threaded rod/cup connection may provide an additional measure of safety even if a crack began and led to complete failure, as the source cup would likely still need to be unthreaded from the rod to release the contained sealed source.

Based on the results of the manufacturer's and the third-party contractor's investigations, and the recommendations made in Troxler's bulletin, users of Troxler model 3400 series gauges with serial numbers less than 13301 are encouraged to have their gauges inspected for cracks in the weld area of the insertion rod. In addition, it is recommended that these gauges be rechecked for cracks on at least a 5 year basis (more or less frequently depending on use level and conditions). It is further recommended that users of model 3400 series gauges with serial numbers 13301 and above also have their insertion rods checked for cracks in the weld area and consider periodic re-inspection, as well.

Inspections of insertion rod weld areas should only be performed by persons qualified to conduct an appropriate nondestructive examination (NDE) for macroscopic cracks (e.g., visual examination with magnification or dye penetrant) and licensed to handle the contained radioactive material. Visual examinations without magnification and examinations by unqualified persons are not recommended, as these could lead to inaccurate results and unnecessary doses to persons performing the examination. Persons who possess Troxler model 3400 series gauges who wish to have their insertion rods inspected should contact either the manufacturer or an NDE inspector qualified to perform the inspection. For guidance on finding qualified NDE inspectors, licensees may contact the Technical Services Division of the American Society for Nondestructive Testing, Inc., at (800) 222-2768 or the Non-Destructive Testing Management Association at (800) 317-0822.

Users who determine that their gauge's insertion rod contains a crack should immediately stop using the gauge and notify the manufacturer. Repair or replacement of cracked insertion rods should only be performed by qualified persons, authorized by license to perform these activities. The manufacturer or other licensee authorized to perform the repair or replacement will indicate the manner in which the gauge should be returned for service.

The incidents and investigations discussed in this notice also demonstrate the need to determine the appropriate weld material, configuration, and processes for a particular use application when designing gauges of this type. The choice of weld specifications should be based on the requirements of the gauge during normal and accident conditions of use that it is likely to encounter during its working life. It is imperative that manufacturers identify these likely conditions as best as possible and design their gauges accordingly. Although the choice of weld material, configuration, and processes for model 3400 series gauges with serial numbers below 13301 appears to be sufficient under normal conditions of use, it appears to provide a means by which a crack could begin in the weld area if subjected to higher than normal bending loads.

This information notice requires no specific action nor written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate regional office.



Donald A. Cool, Director
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

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(301) 415-5847
E-mail: dab@nrc.gov

Attachments:

1. Troxler Bulletin Issued June 1996
2. List of Recently Issued NMSS Information Notices
3. List of Recently Issued NRC Information Notices

Bulletin Regarding Troxler Gauges with Extendable Source Rods

As a result of several recent incidents that have occurred in which the source cup has become detached from the extendable source rod of Troxler 3400 series gauges, Troxler is issuing this bulletin to assist users of surface/moisture gauges in using the gauges safely in compliance with the manufacturer's instructions. Troxler anticipates that this bulletin will help prevent additional source cup detachment incidents.

In order to simplify the manufacturing process, and not due to any incident, 3400 series gauges with serial numbers 13,300 and greater (i.e., manufactured since mid-1986) rely on a combination of a weld and a threaded design to secure the source cup to the source rod. With the addition of threads, the source cups will not dislodge unless the cups are physically unscrewed from the rod. The cases involving detached cups occurred with serial numbers below 13,300 which did not incorporate the threaded design and rely on the weld.

Upon notification of the above incidents, the Troxler Research and Development Department initiated an inspection program for gauges received for service and disposal. This inspection program looked at 310 gauges, 235 received for service and 75 received for disposal. No cracked rods were found in the gauges received for service. In the group of disposal gauges, two rods were identified as having a crack approximately 40% around the circumference. Further evaluation of these two rods demonstrated that they would not fail in normal use or typical accident conditions in the environment in which they are used. Several thousand gauges have been inspected over the last two years. Based on this inspection program Troxler has seen no signs of manufacturing defects. Inspections have revealed some cases of abuse of the equipment.

In an effort to reduce the likelihood of future source cup detachment incidents, Troxler, in cooperation with the North Carolina Division of Radiation Protection, has drafted several recommendations for gauge users as follows:

1. Gauges should be used in accordance with manufacturer's instructions found in the accompanying operator's manual. Under no circumstances should the source rod ever be driven or forced into the test material. A drill rod accessory is provided with the gauge to prepare a hole in the test material into which the source rod is inserted. If the user purchased a used gauge from someone other than Troxler which does not include the accessory, the user should contact Troxler to obtain a drill rod.
2. Troxler recommends that the user return the gauge to the manufacturer at least once every five years to allow the manufacturer to inspect the gauge and source rod for unusual wear and tear.
3. Troxler recommends that companies purchasing used gauges require an inspection by the manufacturer prior to purchase. Troxler takes no position regarding gauge inspections and source rod evaluations performed by anyone other than authorized Troxler Service Centers. Troxler recommends that any gauge involved in an accident be returned to the manufacturer for inspection prior to further use.

For further information, contact Michael Dishman, the Troxler Corporate Radiation Safety Officer, at (919) 549-8661.



**LIST OF RECENTLY ISSUED
 NMSS INFORMATION NOTICES**

Information Notice No.	Subject	Date of Issuance	Issued to
96-51	Residual Contamination Remaining in Krypton-85 Handling System After Venting	09/11/96	All material licensees
96-47	Recordkeeping, Decommissioning Notifications for Disposals of Radioactive Waste by Land Burial Authorized Under Former 10 CFR 20.304, 20.302, and Current 20.2002	08/19/96	All U.S. Nuclear Regulatory Commission licensees
96-35	Failure of Safety Systems on Self-Shielded Irradiators Because of Inadequate Maintenance and Training	06/11/96	All U.S. Nuclear Regulatory Commission irradiator licensees and vendors
96-33	Erroneous Data from Defective Thermocouple Results in a Fire	05/224/96	All material and fuel cycle licensees that monitor temperature with thermocouples
96-28	Suggested Guidance Relating to Development and Implementation of Corrective Action	05/01/96	All material and fuel cycle licensees
96-21	Safety Concerns Related to the Design of the Door Interlock Circuit on Nucletron High-Dose Rate and Pulsed Dose Rate Remote Afterloading Brachytherapy Devices	04/10/96	All NRC Medical Licensees authorized to use brachytherapy sources in high- and pulsed-dose-rate remote
96-20	Demonstration of Associated Equipment Compliance with 10 CFR 34.20	04/04/96	All industrial radiography licensees and radiography equipment manufacturers
96-18	Compliance With 10 CFR Part 20 for Airborne Thorium	03/25/96	All material licensees authorized to possess and use thorium in unsealed form

**LIST OF RECENTLY ISSUED
 NRC INFORMATION NOTICES**

Information Notice No.	Subject	Date of Issuance	Issued to
92-68, Supp. 1	Potentially Sub-standard Slip-On, Welding Neck, and Blind Flanges	09/16/96	All holders of OLs or CPs for nuclear power reactors
96-51	Residual Contamination Remaining in Krypton-85 Handling System After Venting	09/11/96	All material licensees
96-50	Problems with Levering-In Devices in Westinghouse Circuit Breakers	09/04/96	All holders of OLs and CPs for nuclear power plants
96-49	Thermally Induced pressurization of Nuclear Power facility Piping	08/20/96	All holders of OLs or CPs for nuclear power reactors
96-48	Motor-Operated Valve Performance Issues	08/21/96	All holders of OLs or CPs for nuclear power reactors
96-47	Recordkeeping, Decommissioning Notifications for Disposals of Radioactive Waste by Land Burial Authorized Under Former 10 CFR 20.304, 20.302, and Current 20.2002	08/19/96	All U.S. Nuclear Regulatory Commission licensees
96-46	Zinc Plating of Hardened Metal Parts and Removal of Protective Coatings in Refurbished Circuit Breakers	08/12/96	All holders of OLs or CPs for nuclear power reactors
96-45	Potential Common-Mode Post-Accident Failure of Containment Coolers	8/12/96	All holders of OLs or CPs for nuclear power reactors

OL = Operating License
 CP = Construction Permit

Vendor List for Portable Moisture Density Gauges

**Boart Longyear Company
CPN Products
2830 Howe Rd.
Martinez, CA 94533**

**Campbell Security Equipment Co. (CESCO)
2500 Annalisa Dr.
Concord, CA 94520**

**Humboldt Scientific, INC
553E Pylon Dr.
Raleigh, NC 27607**

**Ohmart Corp.
4241 Allendorf Dr.
Cincinnati, OH 45209**

**Seaman Nuclear Corp.
3846 West Wisconsin Av.
Milwaukee, WI 53208**

**Texas Nuclear Products
TN Technologies, INC
2555 North IH-35, P.O. Box 800
Round Rock, TX 78680-0800**

**Troxler Electronic Labs, INC
3008 Cornwallis Rd.
P.O. Box 12057
Research Triangle Park, NC 27709**

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Donald A. Cool, Director
Division of Industrial and
Medical Nuclear Safety
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