



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION IV  
612 EAST LAMAR BLVD, SUITE 400  
ARLINGTON, TEXAS 76011-4125

March 4, 2011

EA-10-249  
NMED 090883

Michael Cheney, TEM Manager  
FMC Corporation  
P.O. Box 872  
Green River, WY 82935

SUBJECT: NRC INSPECTION REPORT NO. 030-06794/2010-001 AND EXERCISE OF  
ENFORCEMENT DISCRETION

Dear Mr. Cheney:

This refers to the inspection conducted on April 27-29, 2010, at your Westvaco facility, located 25 miles west of Green River, Wyoming. The inspectors gathered additional information by telephone, facsimile, and electronic mail from June 4 through October 22, 2010. In office review continued through January 20, 2011. The inspectors discussed the preliminary inspection findings with you at the conclusion of the onsite inspection. Representatives of the NRC's Region IV office conducted a final exit briefing telephonically with you on January 21, 2011. The enclosed report presents the results of this inspection.

The inspection was conducted in response to an event that involved a malfunctioning fixed nuclear gauge used at the Westvaco facility. In addition, this inspection examined activities conducted under your license as they relate to radiation safety and security, and to compliance with the Commission's rules and regulations, as well as the conditions of your NRC license. Within these areas, the inspection consisted of a selected examination of procedures and representative records, observations of activities, and interviews with personnel.

The inspection concluded that six individuals received radiation doses in excess of the regulatory limits for non-radiation workers, which is 0.1 rem. However, based on our review of the circumstances surrounding the event, the NRC has concluded that the equipment failure, which resulted in the radiation exposures, was because the gauge distributor failed to include the required lock washer when installing the sealed source holder into the fixed nuclear gauges.

The inspection found that you met all of your requirements for gauge safety and the defect in the gauge could not have been avoided or detected by your quality assurance program or other related control measures. Your staff discovered the elevated dose rates when following your gauge relocation procedure. FMC Corporation responded correctly to control and to assess the situation to minimize and prevent further exposures, and then to identify individuals that may have been exposed. Your immediate and long-term corrective actions were appropriate.

Normally, these exposures would result in a violation of 10 CFR 20.1301(a)(1), categorized at Severity Level III and would be a candidate for a civil penalty. The staff has reviewed your root-cause analysis of the event and has concluded that the equipment failure could not have been avoided or detected by your quality assurance program or other related control measures. Therefore, based on Section 3.5, "Violations Involving Special Circumstances," of the NRC Enforcement Policy, the NRC is exercising enforcement discretion to refrain from issuing any violation to FMC Corporation in this case.

The NRC has concluded that information regarding the reason for the radiation exposures, the corrective actions taken and planned to prevent recurrence, and the date when full compliance was achieved is already adequately addressed on the docket in your letters and emails dated December 22, 2009, January 12, 14, 20, June 7, September 9, October 22, 2010, and Berthold's letter dated July 1, 2010. Therefore, you are not required to respond to this letter unless the description herein does not accurately reflect your corrective actions or your position.

If you choose to respond, clearly mark your response as a "Reply to EA-10-249, NRC Inspection Report 030-06794/2010-001," and send it to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Regional Administrator, Region IV, within 30 days of the date of the letter transmitting this Inspection Report. Your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. Therefore, to the extent possible, the response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction.

FMC Corporation  
EA-10-249

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In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your reply, if you choose to provide one, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. To the extent possible, your response should not include any personal privacy or proprietary information so that it can be made available to the Public without redaction.

Sincerely,

/RA/

Elmo E. Collins  
Regional Administrator

FMC Corporation  
EA-10-249

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Docket: 030-06794  
License: 49-04295-01

Enclosure:  
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(w/Attachment)

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U.S. Nuclear Regulatory Commission  
Region IV

Docket No.: 030-06794  
License No.: 49-04295-01  
Report No.: 030-06794/2010-001  
EA No.: 10-249  
Licensee: FMC Corporation  
Facility: Westvaco  
Location: Green River, Wyoming  
Dates: April 27, 2010 through January 13, 2011  
Inspectors: Richard Leonardi, Senior Health Physicist  
Nuclear Materials Safety Branch A  
  
Jason Razo, Health Physicist  
Nuclear Materials Safety Branch A  
  
Approved By: Vivian Campbell, Chief  
Nuclear Materials Safety Branch A  
  
Attachment: Supplemental Inspection Information

## **EXECUTIVE SUMMARY**

FMC Corporation  
NRC Inspection Report 030-06794/2010-001

This was a special, announced inspection of licensed activities involving FMC Corporation's (FMC) response to an event (EN45580) involving a malfunctioning fixed nuclear gauge at their Westvaco soda ash plant near Green River, Wyoming. FMC identified the event on December 17, 2009. This report describes the findings of the inspection.

### **Program Overview**

FMC is authorized to use and store byproduct material in the operation of fixed gauges to determine density or level indicator measurements. The licensee possessed 87 fixed nuclear gauges at the time of the event in December 2009. (Section 1)

### **Inspection Findings Considered for Escalated Enforcement**

A malfunctioning fixed gauge caused FMC to conduct operations so that the total effective dose equivalent to non-radiation workers exceeded 0.1 rem in a year. Six individuals were exposed in excess of this limit, which is described in 10 CFR 20.1301(a)(1). Normally, this apparent violation would be considered for escalated enforcement; however, under the circumstances, the NRC is exercising enforcement discretion to refrain from issuing a violation. (Section 7)

### **Selected Corrective Actions**

- On December 17, 2009, the licensee contracted a gauge servicing company to evaluate the malfunctioning gauge. The gauge servicing company completed analysis and repair of the malfunctioning fixed nuclear gauge on December 18, 2009. (Section 5)
- On December 18, 2009, the licensee initiated a public dose assessment to determine the doses received by workers that had been near the gauge. With the assistance of a radiation consultant, the licensee completed the assessment and submitted the final results to the NRC on September 9, 2010. (Section 4)
- In March 2010, the licensee held refresher training with all surface employees, where they discussed the gauge event and lessons learned. (Section 5)

### **Root Cause**

The root cause was determined to be a failure by the manufacturer to install a required lock-washer in the fixed nuclear gauge. Lock-washers were installed on all affected gauges by June 14, 2010. (Section 6)

## Conclusion

The NRC determined that the licensee did not cause the event, that the licensee met all of its quality assurance requirements, and that the licensee could not have prevented the exposures. Once identified, the licensee's actions to assess the exposures and to take effective corrective actions were comprehensive and generally appropriate. (Section 7)

## Report Details

### **1 Program Overview (87124)**

#### **1.1 Inspection Scope**

The inspectors reviewed FMC's license, its previous documented commitments to the NRC, and its previous inspection history with the NRC. Collectively, the documents described the licensee's implementation of its NRC license requirements and its radiation safety and security program.

#### **1.2 Observations and Findings**

Under Materials License 49-04295-01, the NRC authorized FMC for the use of fixed nuclear gauges containing byproduct material. The sealed sources in FMC's fixed gauges ranged in activity from 10 mCi to 500 mCi. FMC used its fixed gauges for density measurements, for determining the ash content of coal, and for level indication. FMC used and stored licensed materials at their Westvaco and Granger soda ash processing facilities. FMC employed 500 surface employees depending on scope of production. The radiation safety officer (RSO), three radiation workers, and trained electrical technicians implemented FMC's radiation safety program.

### **2 Event Chronology (87103)**

#### **2.1 Inspection Scope**

The inspectors reviewed the licensee's event notification and 30-Day report, including supplements and resubmissions, for the malfunctioning gauge event.

#### **2.2 Observations and Findings**

##### *Initial Event Activities*

FMC was authorized to relocate gauges in accordance with its NRC byproduct materials license. On December 17, 2009, a radiation worker and two electricians attempted to execute a work order to relocate a Berthold LB-7440 density gauge to another location. The radiation worker, following the *Radioactive Material Handling Policy* in the FMC Safety and Environmental Procedure Manual, performed a radiation survey of the fixed gauge prior to beginning the relocation process.

Using a calibrated and operable TN 200X radiation survey meter, the radiation worker measured radiation dose rates of 200 mrem per hour at 1 foot from the device. The radiation worker verified the measurement with a separate TN 200X instrument. Radiation exposure rates did not change whether the shutter mechanism of the device was in the open or closed position.

The radiation worker and RSO then established a flagged boundary around the fixed gauge to levels of two mrem per hour or less.

FMC contacted a gauge servicing company, Berthold Technologies USA, LLC (Berthold). Berthold immediately dispatched a technician to the site from Tennessee with the tools and equipment to repair the malfunctioning fixed gauge.

Also on December 17, 2009, FMC contacted the NRC Regional Office in Arlington, Texas, and briefed a senior materials inspector on the event. The senior materials inspector instructed FMC to contact the NRC's headquarters operations officer.

FMC reported the malfunctioning gauge event to the NRC's headquarters operations officer on December 17, 2009, in accordance with 10 CFR 30.50(b)(2), which referenced, in part, an event in which equipment is disabled or fails to function as designed. In this case, the equipment, which was disabled or failed to function as designed, was the shielding of the fixed gauge. Because the source holder became separated from its correct location and shifted to another location within the device, there was not enough shielding to keep radiation exposure rates, as low as reasonably achievable at the new location. As such, FMC met the reporting requirements of 10 CFR 30.50(b)(2).

#### *Event Correction/Remediation Activities*

The Berthold technician arrived on December 18, 2009. The technician verified the abnormal radiation dose rates with a maximum of 614 mrem per hour on contact with the fixed gauge and 200 mrem per hour at 1 foot. The technician disassembled the malfunctioning gauge, isolated the sealed source from the source holder and housing, and transferred the sealed source into a new source holder and new source housing.

The Berthold technician noted during the disassembly process that a lock-washer that was required between the sealed source and the source holder was absent.

FMC checked radiation dose rates around all other fixed gauges of a similar model to the malfunctioning gauge. No other fixed gauges in use or in storage exhibited dose rates that indicated malfunction.

### 2.3 Conclusions

FMC identified the abnormally high dose rates, flagged off a boundary around the area, contacted a gauge servicing company, and reported the event to the NRC. FMC followed its radiation safety policies and procedures and deferred to the gauge service provider for activities that FMC was not authorized to perform.

### **3 Onsite Inspection Findings (87124 and 87103)**

#### **3.1 Inspection Scope**

Interviews with FMC staff and reviews of procedures and records constituted the bulk of the onsite inspection. Licensed activities were examined as they relate to the safety and security of the radioactive material and FMC's policies and procedures for handling licensed materials in storage and in use. The inspectors evaluated training, posting, labeling, and security of licensed material. The inspectors analyzed the statements and conclusions from FMC's 30-Day Event Report.

#### **3.2 Observations and Findings**

The inspectors reviewed records related to preventative and routine maintenance. The inspectors verified that a trained radiation worker performed radiation surveys and followed the appropriate lockout procedures prior to installation, relocation, or removal of any fixed gauges.

##### *Westvaco and Granger Walk Downs*

FMC staff, the Berthold RSO, and the inspectors walked down selected fixed gauges that were in active use at the Westvaco facility. Each gauge had a "Caution, Radioactive Material," sign posted at the installed location. The inspectors performed confirmatory radiation exposure rate measurements using a RadEyeG gamma survey instrument, NRC serial number 086965, calibration due date April 28, 2010. Survey readings showed exposure rates were within regulatory limits and that FMC properly posted radioactive materials storage and use areas. The survey results of the inspectors indicated that the fixed gauges were operating properly at the time of the survey. Fixed gauges of the same model type as the failed gauge and those of other model types were surveyed, as well.

FMC staff explained how the failed fixed gauge was used in their Sesqui Dissolvers area of the Westvaco Plant. The fixed gauge was calibrated to measure the density of fluid passing through the piping to which the fixed gauge was attached. The readings from the fixed gauge were compared to manual grab samples from the process line on a periodic basis. The fixed gauge was mounted on a horizontal section of pipe at the time of failure. The work order being performed at the time of detection was intended to move the gauge to a vertical section of pipe to minimize false readings because of buildup on the interior of the pipe.

In addition to the Westvaco facility inspection, the inspectors reviewed the storage location at the Granger site. The remote Granger site had adequate security controls at the exterior entrance gate to ensure that there was no unauthorized access to the fixed gauge storage sheds. At the Granger site, there were two posted fixed gauge stand-alone sheds. The padlocked sheds contained fixed gauges, with the shutters locked in the closed position. The gauges were awaiting transfer to an authorized recipient or were being held in standby in case a need for their use arose at the Westvaco site.

### *Malfunctioning Gauge Review*

After the facility walk-down, the inspectors reviewed the findings of the Berthold technician that was onsite in December 2010. After the Berthold technician repaired the failed gauge, he left the source housing and other non-radioactive components of the fixed gauge in the custody of FMC. In April 2010, the Berthold RSO explained to the inspectors how the source holder fit into the source housing shell. The sealed source was a model CDC.P4 manufactured by Amersham Corporation containing a nominal 150 mCi of cesium-137. The Berthold RSO stated that the source was found within the tapered cylindrical hole intended to provide a pathway for the radiation beam to be analyzed by the detector on the other side of the process pipe. The sealed source capsule had become separated from the source holder and dropped into the cylindrical hole. A lock-washer intended to prevent this failure mode was absent from this fixed gauge.

### *FMC Staff Interviews*

The inspectors interviewed selected FMC staff members in order to verify the results of FMC's 30-Day Report and inputs to FMC's radiation dose assessment. In FMC's 30-Day Report, dated January 12, 2010 (ML100221805), multiple individuals were identified as having been unintentionally exposed to radiation from the malfunctioning fixed gauge. The inspectors selected some of the exposed individuals as well as other individuals that were not included in the analysis. Interviewees were selected from different work units such as maintenance, operators, Sesqui support, Mono yard staff, electricians, mechanics, radiation safety, and management. Inspectors interviewed FMC staff from multiple shifts and crews where possible.

The inspectors asked the interviewees various questions depending on their familiarity with the event, including basic radiation safety questions such as recognition of radiation warning signs and who to ask if they had radiation safety questions. The inspectors asked the staff about FMC's communication regarding the event. The interviewees responded by confirming that they received a site-wide email announcing the event and a warning to stay out of the area. The workers also mentioned being briefed on the event at the refresher training in March 2010. In addition, some staff stated that they had received a certified letter, which stated the radiation dose they had been assigned in mrem.

The inspectors also focused questions on each person's time spent in the Sesqui Dissolver area, where the event occurred, since the assumed failed date of September 3, 2009 (as discussed in Section 4.2), through discovery on December 17, 2009. Some workers stated that they received the dose letter without having been interviewed by the radiation safety staff. Others stated that they had been in the area periodically, but they had not received a letter.

### 3.3 Conclusions

The inspectors toured fixed gauge storage and use locations at FMC's Westvaco and Granger facilities. They discussed the reasons for the malfunction of the fixed gauge with Berthold, an authorized fixed gauge servicing company. The inspectors interviewed selected FMC staff to determine the extent of exposure times and distances to individuals working in the area of the event. The inspectors verified the order of events as outlined in FMC's 30-Day Report.

## 4 **Radiation Dose Assessment**

### 4.1 Inspection Scope

The inspectors reviewed the initial 30-Day Report dated January 12, 2010, that was submitted by FMC to the NRC in accordance with 10 CFR 30.50(c)(2). The inspectors also reviewed the supplement to the initial report dated January 20, 2010. After the onsite inspection, the NRC requested a revised radiation dose assessment from the licensee. The revised assessment included data and analysis of workers that had not been included in the initial report. The updated 30-Day Report dated September 9, 2010, was reviewed by the NRC. The NRC requested the raw data used to perform the dose analysis, and the data was received on October 22, 2010. These documents, combined with the information received by the inspectors during the onsite interviews, constituted the final radiation dose assessment.

### 4.2 Observations and Findings

#### *Initial 30-Day Report*

The licensee used actual radiation dose measurements to populate a dose map on a drawing of the Sesqui Dissolver area where the malfunctioning gauge was located. Once the event was identified, the FMC radiation safety staff began to note the workers that had been present in the event area. To gather additional information, the radiation safety staff asked a selection of supervisors to provide input on which workers in his/her unit had worked on projects near the event.

Since the exact date of failure was unknown, FMC used the most conservative date available, which was September 3, 2009. On that date, a trained electrician performed a routine "Radiation Shutter Mechanism Test." The test included checking radiation exposure rate levels with a survey instrument. The electrician tested the levels when the shutter was in each the open and closed positions. The result of the test on September 3, 2009, showed a dose rate of 0.5 mR per hour with the shutter open and 0 mR per hour with the shutter closed.

The initial report, therefore, conservatively assumed a fixed gauge failure date of September 3, 2009. The radiation safety staff identified subgroups within the member of the public heading in order to assign the correct dose. Subgroup titles included, for example, Sesqui operators, electricians, mechanics, and management. Taking into

account estimated stay-times and distances, the most exposed group was calculated to have received 62.4 mrem.

#### *Revised 30-Day Report*

After the inspectors identified workers that had been in the area of the event, but had not been assigned a dose, FMC reassessed the radiation doses assessment. Based on the interviews the inspectors conducted with the workers during the onsite inspection, the inspectors determined that some individuals had spent more than minimal time in the event area but had not been evaluated. In addition, the time and distance assumptions used for some individuals appeared to not be as conservative as the statements the individuals made to the inspectors during the interview.

FMC representatives stated that in an effort to expedite the completion of the first dose analysis in January, they had not interviewed every person. Instead, FMC believed that first-line supervisors could provide an adequate perspective on the times that their staff were in the event area. Once the inspectors identified the discrepancy in data points, FMC reevaluated all potentially exposed individuals and submitted the dose analysis section of the report in September 2010.

#### *Dose Reconstruction*

After the NRC onsite inspection in April 2010, FMC contracted with a radiation consultant to assist in the dose analysis. The radiation safety staff and consultant coordinated the expanded dose assessment. Direct interviews with potentially exposed workers occurred between July 19 and August 31, 2010. During the interview, workers were shown a map of the work area where the gauge had malfunctioned. The workers then listed their work activities, dates, and times, for each map location that they could recall for the period of September 3 through December 17, 2009. Based on this data provided by the workers, the radiation safety staff and consultant calculated the total effective dose equivalent for each worker.

Of the 200 individuals analyzed, 159 received less than 10 mrem, 35 received between 10 mrem and 90 mrem, and six received between 109 mrem and 146 mrem.

#### *NRC Independent Dose Analysis*

The inspectors gathered independent data from workers during their onsite interviews in April 2010. In addition, the NRC requested copies of the completed activity/dates/times, feedback forms for selected workers. The forms included the calculations performed by the radiation safety staff or the radiation consultant to determine the final dose for each individual. The inspectors verified that the calculations were correct based on the data the workers provided and the measurements with the radiation survey instrument. In addition, the data on the feedback forms for the selected workers compared favorably to the interview data gathered by the inspectors in April 2010.

#### 4.3 Conclusions

Independent NRC dose analysis confirmed the results performed by FMC and their consultant.

### **5 Corrective Actions (87124 and 86740)**

#### 5.1 Inspection Scope

The NRC reviewed the immediate and long-term corrective actions associated with the malfunctioning gauge event. The inspectors reviewed related procedures and records and interviewed key staff. Finally, the inspectors reviewed the final report submitted in September 2010.

#### 5.2 Observations and Findings

##### *Immediate*

On December 17, 2009, FMC radiation safety staff established a boundary around the malfunctioning gauge to keep doses to workers as low as reasonably achievable and at least less than 2 mR per hour at the boundary. They used flagging and tags stating that there was a "Nuclear Source Issue," to warn workers to stay out of the area. In addition, a company-wide email was sent to all staff. The email stated that there had been an incident and that personnel should stay out of the affected area.

On the same day of the event, FMC contacted a gauge servicing company and the NRC. The gauge servicing company, Berthold, dispatched a technician that day. The NRC instructed FMC to report the event to the NRC Headquarters Operations Officer (HOO). FMC reported the event to the HOO and was assigned event number 45580.

##### *Short-Term*

On December 18, 2009, the licensee initiated a dose assessment to determine the doses received by workers that had been near the gauge from September 3, 2009, through December 17, 2009. The initial 30-Day Report documenting the initial assessment was received by the NRC on January 12, 2010.

The Berthold technician completed analysis and repair of the malfunctioning fixed gauge on December 18, 2009. The technician dismantled the gauge, isolated the source, and inserted the source into a new shield housing. The technician verified that radiation exposure rates were at the expected levels in the repaired gauge.

### *Long-Term*

In March 2010, the licensee held refresher training with all surface employees. The training was held in conjunction with Mine Safety and Health Administration training. During the training, the malfunctioning gauge event was reviewed and questions from the general workers were answered.

On June 14, 2010, Berthold replaced the source shields on 43 other model LB-7440 fixed nuclear gauges onsite. Berthold noted that 35 of the 43 gauges were also missing the required lock-washer. However, none of the sealed sources in the 35 had reached the failure point of becoming detached from the source holder; radiation exposure rates around these gauges were at the expected levels based on the shielding.

#### 5.3 Conclusions

FMC performed immediate, short-term, and long-term corrective actions once the malfunctioning fixed gauge was identified. The corrective actions kept dose rates to workers as low as reasonably achievable.

### **6 Root-Cause Analysis**

#### 6.1 Inspection Scope

The inspectors reviewed FMC's root-cause analysis. The inspectors reviewed the Berthold technician's service report. The inspectors observed the failed gauge and interviewed the Berthold RSO during the onsite inspection.

#### 6.2 Observations and Findings

Based on Berthold's disassembly report, the gauge servicing company, the licensee, and the NRC, each believe the lack of a required lock-washer in the failed gauge was the root cause of the overexposures. The original manufacturer/distributor apparently failed to follow the sealed source and device registry (SS&DR) for this model of fixed gauge. The SS&DR required a lock washer between the sealed source and the source holder, however, it was absent.

The malfunctioning gauge and others onsite from the same distributor had been purchased from BSI, Inc., Pennsylvania, and installed by BSI, Inc., in 1991. The sealed source and interior of the failed gauge had not been inspected or serviced since the original purchase and installation in 1991. Therefore, the absence of the lock-washer was never identified by the licensee until after the investigation into the event that occurred on December 17, 2009.

### *Exacerbating Factors*

The fixed gauge was mounted in a vertical orientation, which was permitted by the SS&DR. Once the source detached from the source holder, the vertical orientation allowed gravity to act directly on the sealed source and caused the source to fall to the bottom plate of the gauge. There was less shielding at the bottom plate than in the center, shielded position since the device was not designed to have the sealed source resting at the bottom plate. This configuration resulted in the elevated dose rates that exposed the workers. If the gauge had been mounted horizontally, or had been rotated 180° vertically, then the absence of the lock-washer may not have resulted in failure. Other devices that were missing lock-washers, did not fail, due, in part, to being mounted horizontally.

The location of the fixed gauge was subject to significant temperature changes. Temperature changes can cause the metallic components of the fixed gauge to expand/contract. The expanding/contracting cycle may have contributed to the gradual loosening of the sealed source from the source holder. The absent lock-washer was intended to mitigate this loosening.

In addition, subtle vibrations in the piping on which the gauge was installed could have increased the rate of separation of the sealed source from the source holder. Vibrations could come from the system as a whole or from changes in flow rates/densities through the piping.

Multiple employees passed in the general vicinity of the fixed gauge on a semi-routine basis. Had the gauge been in a more isolated part of the plant, fewer employees may have been exposed.

### *Mitigating Factors*

Licensee correctly followed its procedures governing radiological activities. By doing so, the licensee minimized the radiological impact on workers at the site. The licensee was using the device as authorized in the SS&DR. While authorized for relocations, the inspectors determined that the licensee would not have reasonably been expected to recognize or diagnose the faulty internal construction of the gauge. Had the gauge been assembled correctly by the manufacturer, no overexposures would have been expected.

The licensee identified the problem when following its radiation safety program to relocate the gauge. According to a condition on the FMC's NRC byproduct materials license, this shutter test is required to be performed every 6 months. The test was not due again until March 2010. Therefore, the execution of the work order, and the proper following of procedure, resulted in identifying the malfunction at least 4 months early.

The inspectors found that the design of the device also minimized the exposures. The steel cover plate prevented the detached sealed source from falling out of the device. In addition, the mounting of the device at a location 12 feet above the primary work floor increased the distance from the workers and the source. Finally, the horizontal metal

pipe on which the device was mounted provided shielding between the sealed source and the main work area below.

### 6.3 Conclusions

The inspectors determined that the root cause of the malfunctioning gauge was the failure to have a lock-washer installed between the source and source holder; this occurred during original manufacturing. Multiple other factors contributed to either exacerbate or mitigate the consequences of the event.

## **7 Findings Considered for Escalated Enforcement**

### 7.1 Inspection Scope

The NRC assessed its inspection findings according to its Enforcement Policy. Factors affecting the assessment include, but are not limited to, severity of consequences, corrective actions, inspection history, and discretion.

### 7.2 Observations and Findings

As previously discussed, six licensee employees that were not radiation workers received a dose in excess of 0.1 rem, the NRC limit described in 10 CFR 20.1301(a)(1). The highest dose received was estimated to be 0.146 rem. As such, this would normally be identified as a violation of 10 CFR 20.1301(a)(1) and considered for escalated enforcement.

The unintended dose was caused by the malfunctioning gauge, which was being used by FMC under its NRC license. The inspectors determined that FMC met all of its license requirements in gauge handling and operation. FMC identified the radiation exposures on December 17, 2009, and took actions to prevent any further exposures to its workers. FMC also notified the NRC of the event as required by 10 CFR 30.50(b)(2).

FMC contracted with a radiation consultant to assist in determining the doses received by its employees. Although FMC's original attempt to determine the doses was incomplete, the licensee corrected this by providing reasonable dose assessments to its workers.

Based on the information from the gauge servicing company that disassembled the gauge and from the inspector's observations of the gauge, the NRC has determined that the cause of the event was that the gauge did not have a lock-washer. NRC determined that the cause of the malfunction was due to error during original manufacturing, and that this event was beyond FMC's control. The staff has reviewed your root cause analysis of the event and has concluded that the equipment failure could not have been avoided or detected by your quality assurance program or other related control measures. Therefore, based on Section 3.5, "Violations Involving Special Circumstances," of the NRC Enforcement Policy, the NRC is exercising enforcement discretion to refrain from issuing any violation to FMC in this case.

### 7.3 Conclusions

The NRC is exercising enforcement discretion to refrain from issuing a violation to FMC in this case.

### 8 **Exit Meeting Summary**

A preliminary exit briefing was conducted at the conclusion of the onsite inspection with Mr. Michael Cheney and his staff on April 29, 2010. A final telephonic exit briefing was conducted with Mr. Michael Cheney of FMC on January 21, 2011, to review the inspection findings as presented in this report. Mr. Cheney acknowledged the inspector's findings. No proprietary information was identified in this report.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

M. Cheney, TEM Manager  
R. Lessey, Counsel  
K. Huber, Human Resources Manager  
S. Cowden, Radiation Safety Officer  
L. Koritkik, former Radiation Safety Officer  
M. Morlock, Steelworkers Union Representative

INSPECTION PROCEDURES USED

87103 Inspection of Materials Licensees Involved in an Incident or Bankruptcy Filing

87124 Fixed and Portable Nuclear Gauges

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

None

Closed

None

Discussed

None

LIST OF ACRONYMS USED

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
EA	Enforcement Action
FMC	FMC Corporation
mCi	millicurie
mR	milliRoentgen
mrem	millirem
NRC	Nuclear Regulatory Commission
RSO	Radiation Safety Officer
SS&DR	Sealed Source & Device Registry