



Nuclear Material Events Database Fixed Gauge Failures (Fiscal Year 2014-2023)

November 2023

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Fixed Gauge Failures
(Fiscal Year 2014-2023)**

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**Prepared for the
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Under U.S. Department of Energy-Idaho Operations Office
Contract DE-AC07-05ID14517**

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Introduction

This report presents an overview of events contained within the Nuclear Material Events Database (NMED) involving fixed gauge failures, with an emphasis on shutter failures. The data is limited to reportable equipment failure events that occurred in Fiscal Years 2014–2023 (FY14-23). The data was extracted from NMED on November 7, 2023. Excluded from this report are events in which a fixed gauge was damaged by an external (i.e., non-process) issue, such as a facility fire.

Fixed gauges containing licensed radioactive material are used by specific and general licensees to measure flow rate, volume, thickness, density, etc., in a variety of industrial settings. Certain types of failures involving these gauges are reportable to the Nuclear Regulatory Commission (NRC) in accordance with 10 CFR 30.50.

Although various types of failures can affect fixed gauges, the most common type of failure involves the shutter or shutter operating mechanism. Fixed gauges typically have shutters that shield the radioactive source when not in use. Many of these gauges routinely operate with their shutters in the open (unshielded) position in harsh environments involving exposure to heat, vibration, foreign debris, corrosive chemicals, weather, etc. Licensees are required to periodically test the operation of the shutter. The failure of a shutter to close properly (i.e., the shutter failed in the unsafe/unshielded position) is required to be reported to the NRC.

As would be expected of reports made by many different personnel, the reports to NRC varied greatly in the amount and quality of information describing individual shutter failures. Descriptions typically contained phrases such as failure to operate, stuck open, failed to fully close, etc. Most reports that listed a cause categorized it as a harsh operating environment, exposure to heat, vibration, foreign debris, corrosive chemicals, weather, etc. Very few reports provided detailed information regarding the exact nature of the failure or repair.

Because fixed gauges normally operate with their shutters open, and the area around the gauge is either inaccessible or controlled as a part of normal operations, events where a shutter is stuck open or otherwise fails to properly shield the source do not usually result in any significant consequences.

The data in this report were adjusted based on NRC Information Notice 2023-02, “Reporting When a Fixed Gauge Shutter Is Stuck in The Closed Position”, issued on March 17, 2023. This Information Notice clarified that shutters stuck in the closed (safe) position are not reportable. Prior to the issuance of the Information Notice, NMED conservatively considered any stuck shutter (stuck open or stuck closed) to be a reportable event. As part of this data analysis task, the data for FY14-23 were reviewed and events involving shutters stuck in the closed (safe) position were modified to be non-reportable events; non-reportable events are excluded from this data analysis task. Note that the Information Notice is not applicable to generally licensed gauges.

The data is not normalized, meaning that the data only considers the reported events and does not directly account for external issues, such as changes to regulatory requirements or the number of devices in use. For example, an increasing trend in the number of events could be caused by an increase in the number of gauges in use. Furthermore, the total number of fixed gauges in use is not readily available and could not be considered in this analysis.

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Discussion

NMED contains 473 events involving the failure of fixed gauges during FY14-23. Some of the events involved more than one gauge. A total of 571 fixed gauges were involved in the 473 events. Figure 1 displays the number of fixed gauges affected during the 10-year period. Note that due to late and follow-up reporting, the data for FY23 are not yet considered complete and may increase in number. Although the data appears to show a gradual decreasing trend, this trend is not statistically significant.

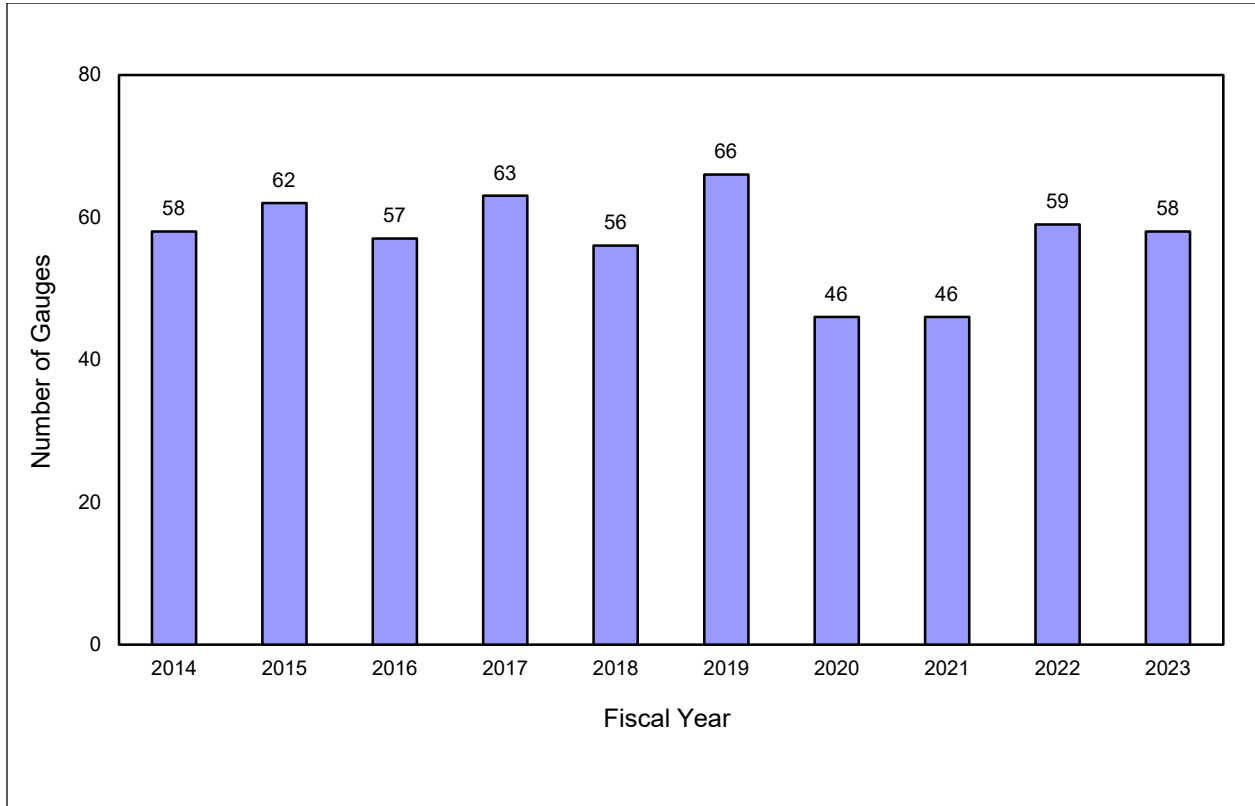


Figure 1. Fixed gauge failures (571 total)

A review of the issues associated with the 473 fixed gauge failure events is shown in Table 1. Most of the events involved the failure of the shutter or shutter operating mechanism; these events are shown in Figure 2. The remaining non-shutter failure events (64 events with 75 gauges) were too infrequent to perform a meaningful failure or trending analysis.

Table 1. Fixed Gauge Failure Issues

Issue	Event Count
Shutter/shutter mechanism	409
Damaged/stuck source retrieval mechanism	14
Gauge damaged by process equipment	9
Leaking source	9
Gauge damaged during inappropriate removal/disposal	7
Degraded shielding	7
Source detached	7
Failure of mounting bracket	4
Gauge damaged by technician	3
Other	4

As shown in Table 1, the vast majority (409 events with 496 gauges) involved failures of the shutter or the shutter operating mechanism. These failures included issues such as the shutter sticking open (unshielded), the shutter operating mechanism failing, or a missing shutter. Figure 2 shows the number of gauges affected during the 10-year period. As mentioned above, the data for FY23 are not yet considered complete due to late and follow-up reporting and may increase in number. Although the data appears to show a gradual decreasing trend, this trend is not statistically significant.

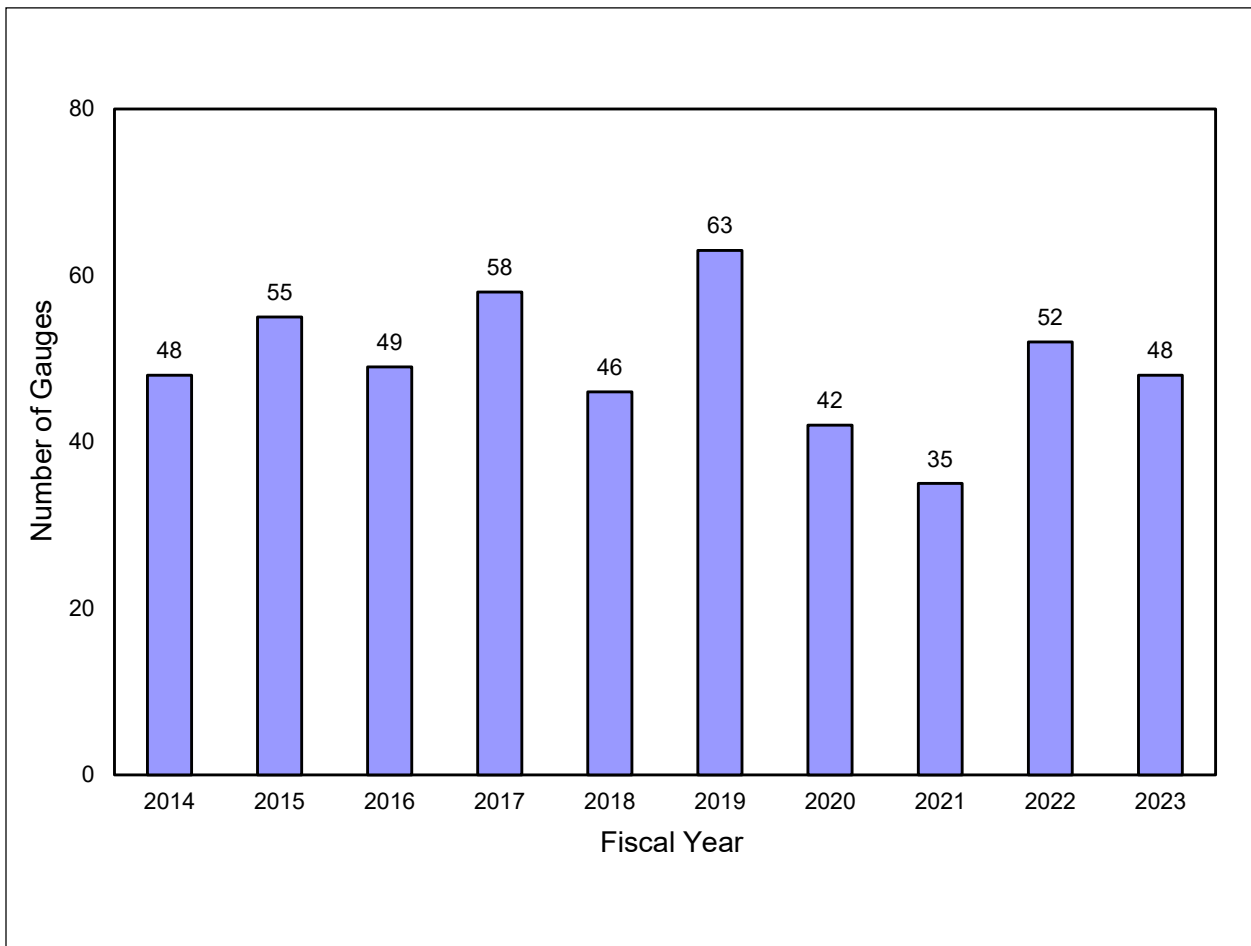


Figure 2. Fixed gauge shutter failures (496 total)

A review of shutter failures associated with specific gauge models was attempted. This review was not exhaustive due to the variety of gauge models and the limited time allotted for this data analysis task. This review was limited to the four most common gauge/model groupings involved in the 409 events. Note that the term “series” is sometimes used in place of “model” below to indicate that variations in the model number were grouped together in the analysis (like SH-F1, SH-F1-A, SH-F1-B, etc.).

Figure 3 shows the shutter failures associated with the Ohmart/Vega series SH-F1 and SH-F2 gauges. Although the data over the last four years (FY20-23) appear to show an obvious increasing trend, the trend over the 10-year period is not statistically significant. With the possible exception of the spike in FY23, the data fluctuations for FY20-23 are consistent with the data fluctuations over the earlier years. This possible trend should be monitored over the coming years.

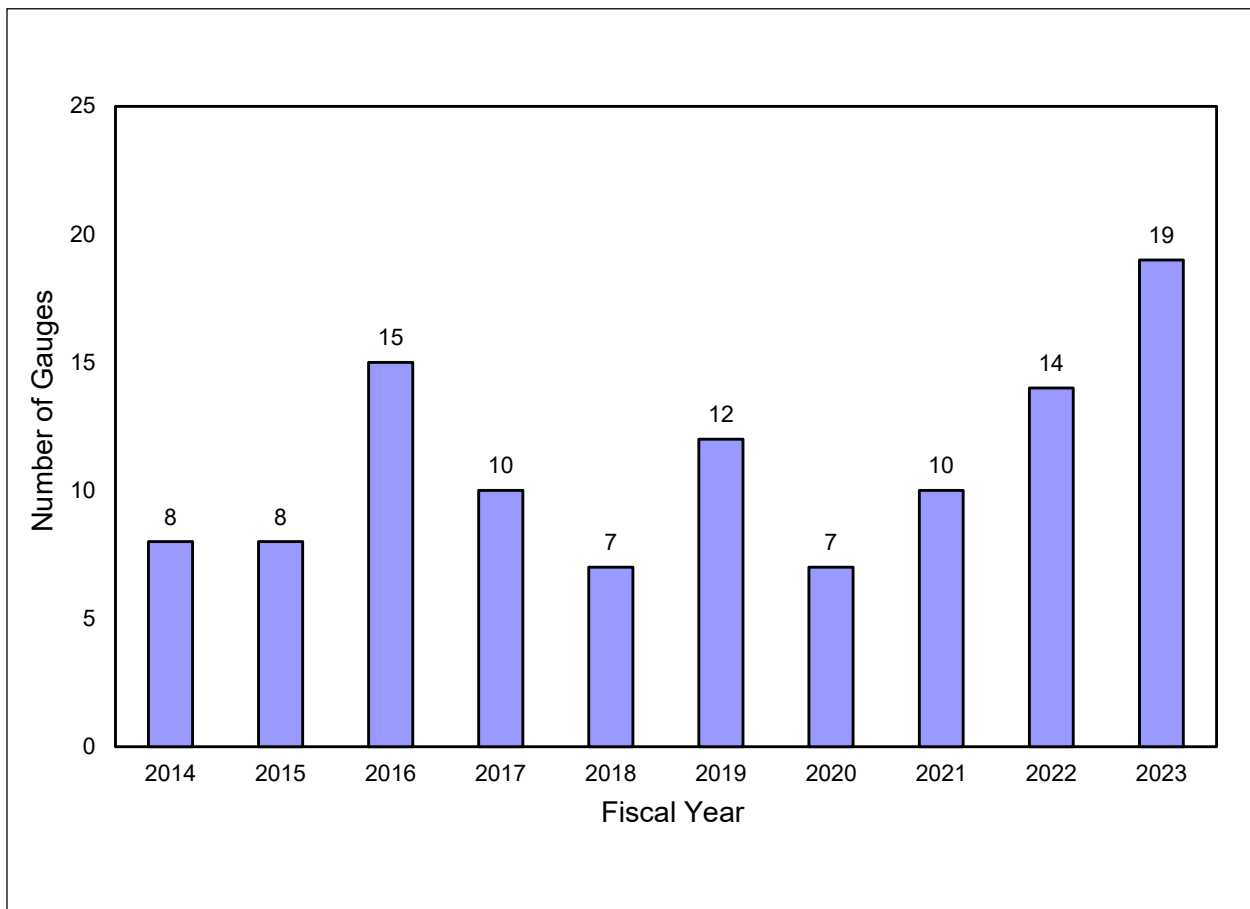


Figure 3. Ohmart/Vega series SH-F1 and SH-F2 shutter failures (110 total)

Other gauge models that were reviewed included the Ronan series SA-1 gauges, Berthold series LB-7400 gauges, and Kay-Ray/Sensall gauges (all models). None of these gauge models showed a statistically significant trend.

In conclusion, no statistically significant trends were identified in this brief review of fixed gauge failure events. This includes possible trends in the overall events, as well as possible trends for specific gauge models.