

WHAT A LAB DATA ERROR COSTS

The Sabine Industrial Lab Data Error Study, 2026

sabineindustrial.com/research/what-a-lab-data-error-costs

A lab result certifies a batch, clears a cargo, keeps a transformer in service or tells a town its water is safe. The people who make those calls usually see only the number. When the number is wrong, late or filed where nobody looks, they make the call anyway.

A quality lab is usually budgeted as a cost. The cases below show what that cost is meant to prevent. We wanted to know what bad, late or missing lab data has cost on the public record, and what separated the small costs from the large ones.

The Sabine Industrial Lab Data Error Study read the public record behind 100 incidents and enforcement actions from 2015 to 2026 in fuels, pipelines, chemicals, utilities and testing labs. In each one, a lab data failure let off-spec product reach customers, shut down a facility or drew a regulator's penalty. In interviews for our [replacement study](#), a refining and pipeline company's quality lab told us an error can cause a system-wide closure.

Summary

Every case in this record turned on a test result or the record of one. The lab's tools decide whether a bad result is caught in the lab or found by a customer. The same gaps show up across industries:

- **No alert when results head the wrong way.** Results over the limit went without action at a London substation, a Navy fuel facility, a Singapore fuel supplier and an Ohio water system. At a Montana coal plant, regulators found that an emissions test at the limit should have raised concerns before a later test failed and shut two units for months.
- **No audit trail.** When a result can be changed without a record of who changed it, falsified results can run for decades, as they did at a Navy castings supplier.
- **No check that required tests ran.** Imported fuel was sold without being sampled and tested, and a regulator listed a missing dissolved gas analysis among the causes of a transformer failure.
- **No check of incoming material against the full spec.** A fuel oil cargo arrived with a certificate showing about 20 parameters on spec and contaminants outside that list, and a contaminated supplier chemical reached a chipmaker's production line.
- **No check against the current spec and method.** A summer gasoline batch went into commerce after being certified over the volatility limit, and a biodiesel plant was fined for certifying sulfur with a method the EPA had not qualified.
- **Results copied by hand.** In two published health care audits, up to 3.7 percent of values copied by hand did not match the source.
- **Results nobody can find.** A seismic damper maker could not confirm the status of 12,353 installed units, and aircraft operators learned of contaminated jet fuel only when someone reviewed the fueling records.

The examples below show what these gaps cost.

HOW FAR IT GOT

\$7,000 to \$1.2 billion

The further bad product traveled before someone acted, the more it cost. Among lab data failures in these industries, costs to organizations ran from a \$7,000 fine to \$1.2 billion after jet fuel reached a Navy drinking-water system serving about 93,000 people.

A DAY DOWN

About \$11 million

In company reports on unplanned outages, whatever the cause, a day cost about \$80,000 at a fertilizer plant, \$1 million to \$2 million at chemical plants and about \$11 million at a large Midwest refinery.

A RESULT NOBODY ACTED ON

Nearly 7 years

passed between an oil test that flagged an imminent transformer fault and the fire that shut Heathrow.

A TEST NEVER RUN

\$15 million

An internal assessment called for more sampling at a gas pipeline compressor station. It was never done, and the piping later ruptured and burned, causing an estimated \$15 million in damage.

A SPEC THAT MISSED IT

100 million liters

Gasoline cargoes carrying methanol passed inspection at two ports, and more than 100 million liters were pulled from distribution in Nigeria.

NO TRAIL

About 30 years

A lab director altered failing test results on steel castings for Navy submarines for about 30 years, and went to prison.

A RESULT NOBODY COULD FIND

\$266,900

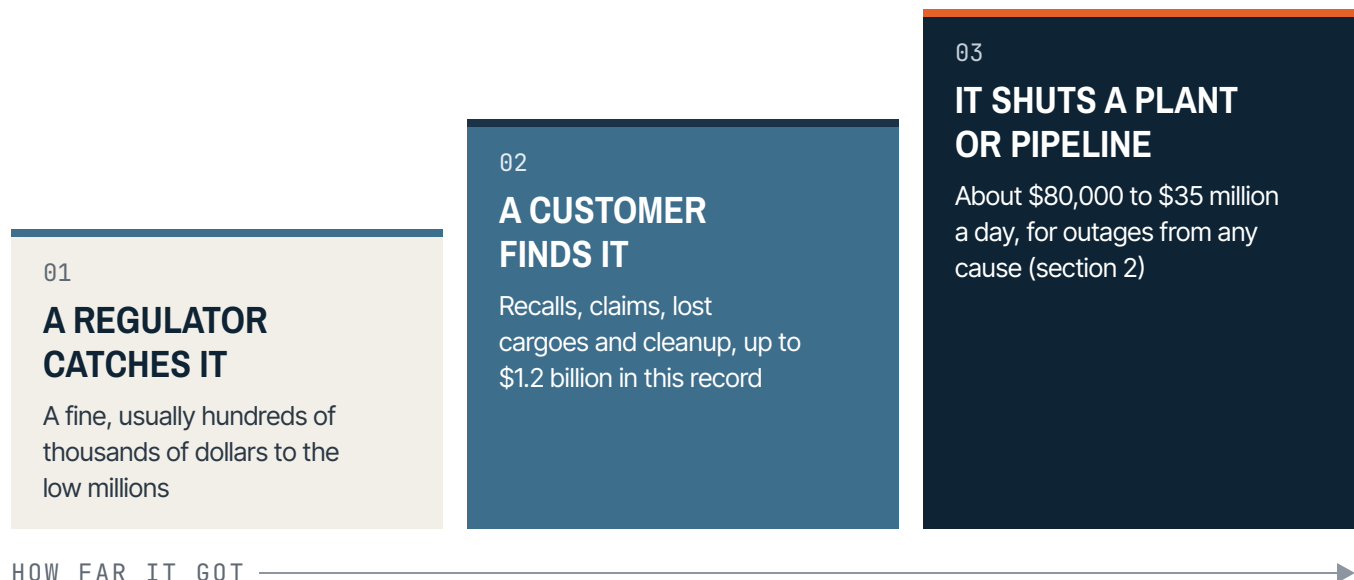
A drinking-water lab was fined \$266,900 for 2,633 late results and lost data.

1. The cost depends on how far the product gets before someone acts

At the low end, a California environmental lab was fined \$7,000 for reporting tests it was not accredited to run. At the high end, Congress appropriated at least \$1.2 billion after jet fuel from the Navy's Red Hill fuel facility got into drinking water.

Errors that a regulator caught, in an audit or its own sampling, mostly cost a penalty, usually in the hundreds of thousands of dollars to the low millions. Errors found by a customer, a ship's engineer or a resident cost recalls, claims, lost cargoes, cleanup and closures.

What a bad result cost, by how far it got



2. A day down can cost more than a fine

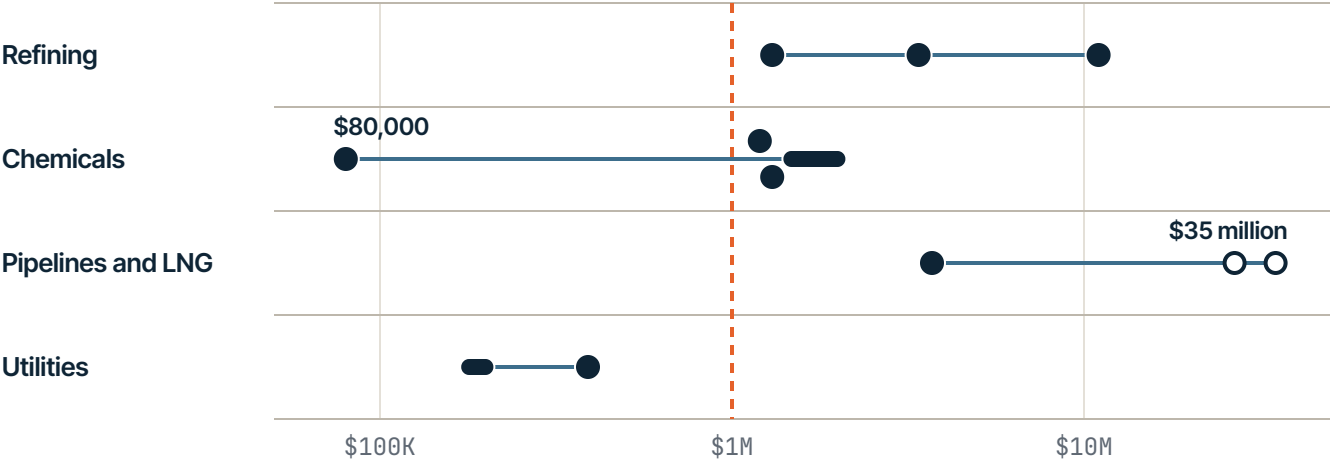
Most fines in this record were under \$1 million. When a plant or pipeline stops, the cost runs by the day. In 9 of the 12 outages below, a single day cost more than \$1 million.

Few companies publish what a day of downtime costs, but some report what an unplanned outage took off their earnings, and regulators rule on what utilities may charge customers for replacement power. Where a source gave no daily figure, we

divided its reported cost by the days that cost covers. Only one of these outages, at a coal plant in Montana (section 3), followed a test result that a regulator found should have prompted action. The rest show what a day down costs in these industries, whatever the cause.

A day of downtime cost from about \$80,000 to \$35 million

- One outage
- ▬ Reported as a range
- ⋮ Most fines in this record were under \$1 million
- Lost revenue across a whole export pipeline or the UK North Sea



Per day, in US dollars, on a log scale.
Euros, pounds and yen converted at about \$1.06 to the euro, \$1.34 to the pound and ¥135 to the dollar.

INDUSTRY	WHAT WENT DOWN	REPORTED COST	PER DAY
Refining	Large Midwest refinery: plant-wide power outage, 2024	Around \$0.5 billion in lost refining margin; about 46 days to normal operations	About \$11 million
	OMV's Schwechat refinery, Austria: distillation column damaged in a pressure test, 2022	Around €90 million for the 28 days to June 30, with the refinery running at reduced capacity	About €3.2 million
	California refinery: fire early in a planned turnaround, 2025	\$78.1 million in response, cleanup and restart costs over 59 days, not counting lost margin	About \$1.3 million

INDUSTRY	WHAT WENT DOWN	REPORTED COST	PER DAY
Chemicals	Virginia chemical plant: production cut after a winter-weather breakdown, 2018	About \$30 million off pretax income; repairs took two to three weeks	About \$1.4 million to \$2.1 million
	Tennessee chemical complex: explosion, 2017	\$112 million off pretax earnings in the 89 days to year-end	About \$1.3 million
	Chemours' Altamira pigment plant, Mexico: three-week shutdown in a drought, 2024	About \$26 million in downtime costs over two quarters	About \$1.2 million
	Oklahoma fertilizer plant: 46 days of unplanned downtime at its urea plant, 2015	\$3.5 million to \$4.0 million off operating results, including repairs and lost margin	About \$80,000
Pipelines and LNG	Iraq-Turkey crude pipeline: exports halted, 2023	\$7 billion in lost revenue over 200 days to Iraq, the Kurdistan region and oil companies, by a producers' association's count	\$35 million (as reported)
	North Sea crude pipeline: shut to repair a crack, 2017	Lost production across the UK North Sea of around £20 million a day, by an industry body's estimate	£20 million (as reported)
	Texas LNG export plant: fire, 2022	¥147.7 billion off the profit of one Japanese buyer and part-owner, in the 297 days to March 31, 2023	About ¥500 million
Utilities	Minnesota nuclear plant: control cables cut by mistake, 2023	\$40.6 million refund of replacement power costs ordered for the 103-day outage	About \$390,000
	Montana coal plant: failed emissions test, 2018	\$15.4 million in replacement power Washington's regulator would not let the owners recover from customers, over 75 to 90 days	About \$170,000 to \$210,000

Per day is the reported cost divided by the days shown, unless marked as reported.

Costs are as first reported, before any insurance recoveries. Each source counts a different kind of cost, such as lost margin, repair and restart costs or replacement

power, so compare the figures for scale only.

3. Some of the costliest failures started with a result nobody acted on

In July 2018, an oil sample from a transformer bushing at the North Hyde substation in west London came back at the highest moisture level in the operator's own guidance. That level meant "an imminent fault and that the bushing should be replaced." The government-commissioned review found the reading had been recorded in the operator's online system and that the actions it called for "were not actioned." On March 20, 2025, the bushing failed and the transformer caught fire. Heathrow closed for most of the next day. More than 1,300 flights were canceled and more than 270,000 passenger journeys disrupted. British Airways' owner put its own cost at £40 million, and airlines put the total cost at £80 million to £100 million. Ofgem, the UK energy regulator, opened an enforcement investigation in July 2025.

At Red Hill, the Navy's own investigation found that well samples taken in August 2021 exceeded the action level and were "not considered an immediate concern." Results reached the state regulator about two months after the samples were taken. In November, fuel reached residents' taps. The Defense Department has since decided to close the facility permanently.

In Singapore, between March 21 and 23, 2022, a testing lab hired by Glencore Singapore reported chlorinated organic compounds in fuel oil the company had bought for blending. According to the Maritime and Port Authority, the company kept supplying marine fuel blended with it to 24 ships from March 22 to April 1. About 200 ships received the fuel and about 80 reported pump or engine problems. The authority suspended the company's bunkering license for two months.

At a coal plant in Montana, the quarterly stack test for particulate emissions in February 2018 came in exactly at the site's limit: a pass, but the highest result ever recorded for two of its units. Washington's utility regulator later found that the result "should have raised concerns that triggered, at a minimum, collaboration and communication regarding steps necessary to avoid a forced shutdown." In June both units failed a test and were taken out of service until September. In a 2-1

decision, the regulator found too little record of the owners' decisions to show they had acted prudently, and refused to let three of them recover \$15.4 million in replacement power costs from customers. Montana's regulator held another co-owner responsible for about \$6.3 million more.

In June 2024, a production lot of GM's ACDelco brake fluid failed a federal compliance test at a third-party lab for visible sediment. GM was told 14 months later, and 40,440 bottles were recalled in April 2026. In Sebring, Ohio, lead results over the limit came back from 7 of 20 homes in the summer of 2015. Customers were supposed to be told within 60 days. They weren't told until January 2016, and schools closed. A major US refiner paid the EPA \$647,988 in 2021 after a batch of summer gasoline went into commerce even though it had been tested and certified over the volatility limit.

4. Some tests were never run

At an interstate gas pipeline's compressor station in Pennsylvania, an internal assessment after a 2015 corrosion leak called for more sampling. The sampling was never done. In December 2016 the piping ruptured and burned, causing an estimated \$15 million in damage. The regulator, PHMSA, found that "no fluid samples have ever been collected and tested to monitor for internal corrosion." The operator paid a \$718,700 penalty.

A fuel importer serving Alaska and Washington paid the EPA \$389,785 in 2026 for selling imported gasoline and diesel "without first sampling and testing the fuels." At a Canadian utility, moisture got into a generator transformer during a repair, and the transformer failed. Among the causes, the regulator listed "a missing dissolved gas analysis." The transformer was out of service for 78 days. Replacement power cost about C\$1 million, which the utility recovered from its insurer.

In early 2019, a batch of photoresist from a chemical supplier reached TSMC's production line with an abnormally treated component. The problem showed up only when wafer yields fell. TSMC said the incident would cut first-quarter revenue by about \$550 million. The scrapped wafers were made up the next quarter, and TSMC tightened its checks on incoming materials.

5. Some products passed their tests because the tests didn't cover the problem

In early 2022, four gasoline cargoes carrying methanol passed inspection at the load port in Belgium and again on arrival in Nigeria. The head of NNPC, Nigeria's national oil company, said the inspection protocol at both ports did "not include the test for percent methanol content." More than 100 million liters were pulled from distribution. During the shortage, gasoline sold on the black market for around 500 naira a liter, against 162 naira at the pump.

Marine fuel has had the same problem more than once. In 2018, fuel with contaminants that the standard ISO 8217 test methods could not detect seized fuel pumps on ships supplied in Houston, Panama and Singapore. In 2023, fuel sold as meeting ISO 8217 did the same in Houston. Claims of up to \$186 million have followed. A buyer in Curaçao paid \$9 million for a 2018 cargo whose certificate covered about 20 standard parameters, all on spec. The contaminants were outside that list. The fuel was sold as slops, and a New York court held the certificate "final and binding."

In Hong Kong in 2015, lead in new public housing plumbing went undetected because the water department's acceptance checks "focused exclusively on functionality." The Housing Authority spent about HK\$60 million on bottled water alone. A Midwest biodiesel plant paid the EPA \$203,555 in 2026 for certifying sulfur with a test method the agency had not qualified, even though the product was within the limit.

6. Wrong numbers are usually ordinary mistakes, but altered results can go undetected for decades

California's Air Resources Board settled with refineries over "incorrect lab practices" (\$88,000), "a calculation error" in a refinery laboratory (\$60,000), and "a calculation error due to a malfunction" of a laboratory instrument (\$119,000). In one case the fix was new steps to validate results before they were reported. In the others it was revised operating procedures.

In cargo trading, the buyer is paying for what the certificate says. In a 2026 English court case, both sides agreed that a certificate showing a fuel oil cargo's organic chlorides below 1 ppm "was erroneous." Two US Gulf Coast refiners rejected the cargo, and the court put the loss at \$26 million, which stayed with the buyer. In the Druzhba pipeline contamination of 2019, documents reviewed by Reuters certified crude as meeting the organic-chloride limit while it carried 80 to 330 ppm against a limit of 10. Flows to Europe stopped for weeks, and Transneft set aside 26.1 billion rubles for compensation. In Belarus, where refineries ran at about half their usual rate, the state petrochemical group Belneftekhim put its lost earnings for April at close to \$100 million in a first estimate.

At Bradken's foundry in Tacoma, the lab director altered failing test results on steel castings for US Navy submarines for about 30 years. The company paid \$10.9 million to settle, the Navy says it has spent nearly \$14 million on the problem, and the director went to prison.

7. A result you can't find costs money too

A large commercial drinking-water lab in California was fined \$266,900 in 2023 for 2,633 late results and "35 samples where the laboratory failed to maintain a system to control records and data was lost." KYB, a Japanese maker of seismic dampers, found that 998 installed units did not conform and that the status of 12,353 more was unknown, and set aside ¥35 billion for warranty costs. When diesel exhaust fluid was loaded by mistake into the additive tanks of jet fuel trucks at US airports, the FAA noted that aircraft operators "were not informed until review of the fueling records."

At ČEZ's Dukovany nuclear plant in the Czech Republic, X-ray images of pipe welds proved too poor to show the condition of the welds. In 2015 three of its four reactors went offline while the welds were inspected again. ČEZ blamed its main contractor. Its chief executive called it deliberate cheating and put the cost to the company in 2015 at 2.5 billion Czech crowns.

8. Most errors happen before or after the measurement

In a widely cited hospital lab study, about 68 percent of mistakes happened before the analysis and about 19 percent after it. About 13 percent happened in the analysis itself. Industrial labs have no equivalent public study, but the steps are the same: sample, log in, test, transcribe, review, report.

In two published audits, 2.8 percent and 3.7 percent of values copied by hand did not match the source. Both audits were in health care. Checking by eye doesn't fix it. In a controlled study, visual checking produced about 30 times as many errors as independent double entry, and statistically it was no better than entering the data once. Field audits of working spreadsheets found errors in 94 percent of the 85 examined. When chemistry labs explained failed proficiency tests, wrong units and transcription errors were each about 5 percent of the causes they reported. Equipment failure was 8 percent.

The cases at a glance

YEAR	WHERE	WHAT WENT WRONG IN THE DATA	COST ON THE RECORD
2018 to 2025	North Hyde substation, London	Transformer oil result showing imminent fault recorded, never acted on	Heathrow closed most of a day; £40m to one airline group; airlines' estimate £80m to £100m
2021	Red Hill fuel facility, Hawaii (US Navy)	Monitoring well over action level not treated as urgent	At least \$1.2 billion appropriated; facility to be closed permanently
2022	Singapore bunkers (Glencore Singapore)	Lab it hired found contaminant; supply continued 10 days	License suspended 2 months; about 80 ships reported problems
2018	Coal plant, Montana	Emissions test at the site's limit drew no documented response; a later test failed	Two units out until September; \$15.4m (Washington) and about \$6.3m (Montana) in replacement power the owners could not recover from customers

YEAR	WHERE	WHAT WENT WRONG IN THE DATA	COST ON THE RECORD
2024 to 2026	GM ACDelco brake fluid	Failed compliance test; recall 22 months later	40,440 bottles recalled
2015 to 2016	Sebring, Ohio	Lead results not passed to customers for months	Emergency order; schools closed
2016	Gas pipeline compressor station, Pennsylvania	No fluid samples ever taken for corrosion	\$15m damage; \$718,700 penalty
2019	TSMC, Taiwan	Contaminated supplier chemical not caught on arrival	About \$550m off one quarter's revenue, made up the next
2022	NNPC, Nigeria	Import test slate did not include methanol	100m+ liters withdrawn; national shortage
2018, 2023	Houston, Panama, Singapore bunkers	Fuel passed ISO 8217's standard tests, which don't detect the contaminant	Claims of up to \$186m
2015	Hong Kong public housing	Acceptance tests did not cover lead	About HK\$60m in bottled water
2017 to 2019	California refineries	Lab practice and calculation errors in reported results	\$60,000 to \$119,000 per case
2022 to 2026	Fuel oil cargo, Mercuria v Onex	Certificate of analysis "erroneous"	\$26m loss to the buyer
2019	Druzhba pipeline (Transneft)	Certificates showed crude on spec; it was not	26.1bn-ruble reserve; claims up to \$1bn (Reuters sources); Belarus put April losses near \$100m
to 2017	Bradken foundry, US Navy castings	Lab results altered for about 30 years	\$10.9m settlement; about \$14m Navy cost; prison

YEAR	WHERE	WHAT WENT WRONG IN THE DATA	COST ON THE RECORD
2023	California drinking-water lab	2,633 late results; 35 samples' data lost	\$266,900
2015	Dukovany nuclear plant, Czech Republic (ČEZ)	Weld X-rays too poor to show the welds' condition	Three of four reactors offline; 2.5bn Czech crowns lost in 2015 (CEO's figure)
2025	California environmental lab	Results reported outside accreditation	\$7,000

The full table of 100 cases, with every source, is available on request.

How we did the study

We read the public record behind incidents and enforcement actions from 2015 to 2026 in fuels, lubricants and fluids, chemicals, pipelines and terminals, utilities and testing labs. A case counted when testing, certificates, sampling or the handling of lab data was part of the failure. The records were regulator orders and reports, inquiries, court judgments, Justice Department releases, company statements and filings, and press that cites a primary document. Six cases come from other industries where the failure was the same. The downtime costs in section 2 come from company reports, regulator rulings and industry bodies, whatever caused the outage. Most recorded costs are partial: a fine or a settlement, rarely the full cost of an incident.

ABOUT SABINE INDUSTRIAL

Sabine Industrial builds SI LIMS for fuel, energy, utility and chemical quality labs. Our team has spent fifteen years working with data extracts from every major LIMS. This is the fourth study in a series on how labs buy, run and replace a LIMS.

Questions about the data: info@sabineriverpartners.com

Sources

Cases are listed in the order they appear. Companies are described as in the text; each link goes to the public record.

1. California environmental lab, State Water Resources Control Board (ELAP) citation, April 2025. https://waterboards.ca.gov/dinking_water/certlic/labs/documents/laboratoryassessments/citation-pet-2387-041625.pdf
2. US Navy, Red Hill Bulk Fuel Storage Facility: Navy command investigation, June 2022 (released by EPA). <https://epa.gov/system/files/documents/2022-07/FOIA-Release-Red%20Hill-CI-%28June%202022%29.pdf> ; GAO-24-106185, February 2024. <https://www.gao.gov/products/GAO-24-106185> ; residents' reports and the wait for confirmation, Civil Beat, December 2021. <https://www.civilbeat.org/2021/12/delay-in-confirming-petroleum-laced-water-exposes-need-for-local-test-site>
3. Downtime costs in section 2, in table order. Large Midwest refinery: the owner's second-quarter 2024 trading statement (SEC Form 6-K). <https://www.sec.gov/Archives/edgar/data/313807/000165495424008717/a5832v.htm> ; return to normal operations (Reuters via Hydrocarbon Processing), March 2024. <https://hydrocarbonprocessing.com/news/2024/03/bps-indiana-us-refinery-back-to-normal-operations-after-feb-outage/> ; OMV trading update, July 2022. <https://omv.com/downloads/2022/07/85494c18-965c-433b-8889-4332c246e3e2/trading-update.pdf> ; California refinery: the owner's 10-Q for the first quarter of 2025. <https://www.sec.gov/Archives/edgar/data/1534504/000153450425000031/pbf-20250331.htm> ; Virginia chemical plant: first-quarter 2018 results release and 10-Q. <https://www.sec.gov/Archives/edgar/data/1673985/000167398518000053/q12018exhibit991earningspr.htm> ; <https://www.sec.gov/Archives/edgar/data/1673985/000167398518000055/a331201810q-1.htm> ; Tennessee chemical complex: fourth-quarter 2017 results tables. https://www.sec.gov/Archives/edgar/data/915389/000091538918000007/ex99_0120171231cctables.htm ; Chemours, second- and third-quarter 2024 results releases. https://www.sec.gov/Archives/edgar/data/1627223/000095017024089310/cc-ex99_1.htm ; https://www.sec.gov/Archives/edgar/data/1627223/000095017024120258/cc-ex99_1.htm ; Oklahoma fertilizer plant: the owner's 2015 annual report discussion and fourth-quarter 2015 results release. https://www.sec.gov/Archives/edgar/data/60714/000156459016024742/lxu-ex992_14.htm ; <https://www.sec.gov/Archives/edgar/data/60714/000119312516486098/d151888dex991.htm> ; Iraq-Turkey crude pipeline: APIKUR, October 2023. <https://www.apikur.uk/publications/apikur-explains-200-days-since-the-halt-of-exports-through-the-iraq-tuerkiye-pipeline-7-billion-lost-export-revenue/> ; <https://www.rudaw.net/english/middleeast/111020232> ; North Sea crude pipeline: Oil & Gas UK statement, December 2017. <https://oeuk.org.uk/forties-pipeline-system-updated-statement> ; the crack and the restart (UPI), December 2017. <https://www.upi.com/All-restrictions-on-Forties-pipeline-system-lifted/6491514469021/> ; Texas LNG export plant: results presentation of a Japanese buyer and part-owner, for the year to March 2023. https://www.daigasgroup.com/ir/library/earnings/_icsFiles/afieldfile/2023/05/08/20230508_2.pdf ; Minnesota nuclear plant: Minnesota Public Utilities Commission, May 2026. <https://content.govdelivery.com/bulletins/gd/MNPUBUC-4164666> ; the Montana coal plant is listed with its case below.
4. North Hyde substation: National Energy System Operator, final report, July 2025. <https://www.neso.energy/news/final-report-review-north-hyde-substation-outage> ; Ofgem investigation (open). <https://www.ofgem.gov.uk/press-release/ofgem-opens-investigation-national-grid-electricity-transmission-nget-north-hyde-substation-fire> ; flights canceled (AP). <https://www.inddist.com/operations/news/22944771/costly-bushings-failure-shut-down-heathrow-airport> ; passenger journeys (PA). <https://www.expressandstar.com/uk-news/2025/07/02/substation-fire-that-shut-heathrow-airport-was-preventable-says-watchdog-report> ; airline group cost. <https://www.cityam.com/heathrow-closure-cost-british-airways-owner-40m/> ; airlines' claimed cost. <https://electricalreview.co.uk/2025/07/02/heathrow-mulls-legal-action-against-national-grid-for-fire-shutdown/>
5. Maritime and Port Authority of Singapore, findings, April and August 2022. <https://www.mpa.gov.sg/media-centre/details/update-on-mpa-s-preliminary-findings-on-reported-bunker-fuel-contamination-in-singapore-port> ; <https://www.mpa.gov.sg/media-centre/details/mpa-completes-its-investigations-into-bunker-fuel-contamination-in-singapore-port>

6. Coal plant in Montana: Washington Utilities and Transportation Commission, Final Order 05, Docket UE-190882, March 2020. <https://apiproxy.utc.wa.gov/cases/GetDocument?docID=756&year=2019&docketNumber=190882> ; Commission release, March 2020. <https://utc.wa.gov/news/2020/regulators-deny-154-million-rate-recovery-related-2018-colstrip-outage> ; Montana Public Service Commission release, October 2020. https://psc.mt.gov/_docs/news/pr/2020PR/2020102-NWE-PCCAM-Decision.pdf
7. NHTSA recall report 26E025, ACDelco DOT 3 brake fluid, April 2026. <https://static.nhtsa.gov/odi/rci/2026/RCLRPT-26E025-5872.pdf>
8. Sebring, Ohio: WOSU/AP, January 2016. <https://wosu.org/news/2016-01-25/ohio-agency-seeks-criminal-investigation-into-water-plant-problems> ; Allegheny Front, January 2016. <https://www.alleghenyfront.org/in-an-ohio-town-officials-waited-months-to-disclose-dangerous-lead-levels/>
9. Major US refiner, EPA consent agreement and final order, September 2021. <https://www.epa.gov/system/files/documents/2021-09/chevronusainc.pdf>
10. Interstate gas pipeline compressor station, Pennsylvania: PHMSA notice of probable violation, November 2018. https://primis.phmsa.dot.gov/enforcement-documents/120181005/120181005_NOPV%20PCP%20PCO_11162018_text.pdf ; final order, June 2019. https://primis.phmsa.dot.gov/enforcement-documents/120181005/120181005_Final%20Order_06192019_text.pdf
11. Fuel importer, Alaska and Washington, EPA consent agreement and final order, May 2026. https://yosemite.epa.gov/oa/EAB_Web_Docket.nsf/4d60a7db00f72aa685258e06006de32c/13aab6bb2425063985258dfc00592e9d!OpenDocument
12. Canadian utility, Nova Scotia Energy Board decision 2025 NSEB 10, October 2025. <https://nserbt.ca/sites/default/files/NSEB%20Board%20Decision%20-%20Nova%20Scotia%20Power%20M11533.pdf>
13. TSMC statement, February 15, 2019. <https://pr.tsmc.com/english/news/1984>
14. NNPC, Nigeria, February 2022: statement of the Group Managing Director. <https://shippingposition.com.ng/how-adulterated-fuel-was-imported-into-nigeria-nnpc-gmd/> ; S&P Global Commodity Insights. <https://www.spglobal.com/commodity-insights/en/news-research/latest-news/crude-oil/020922-nigeria-on-brink-of-fuel-shortages-after-it-discovers-off-spec-gasoline> ; AFP. <https://seychellesnewsagency.com/articles/16329/week-long-fuel-scarcity-hits-oil-rich-nigeria>
15. Marine fuel contamination: US Coast Guard safety alert, June 2018. <https://gcaptain.com/safety-alert-bad-bunker-fuel-causing-problems-for-vessels-on-u-s-gulf-coast/> ; Panama claim. <https://www.seatrade-maritime.com/bunkering/panama-court-rules-186m-glencore-bunker-case-can-proceed> ; 2023 Houston claim. <https://shipandbunker.com/news/am/203786-cma-cgm-sues-houston-physical-supplier-over-alleged-bad-bunkers> ; P&I club review of the 2018 cases (Houston, Panama, Singapore). https://www.American-Club.com/files/files/off-spec_fuel_oil_epidemic_preparing_for_beyond_2020.pdf
16. Curacao Oil N.V. v Trafigura Pte. Ltd., New York Supreme Court, 2020. https://www.nycourts.gov/reporter/3dseries/2020/2020_50752.htm
17. Hong Kong Legislative Council paper on the Commission of Inquiry into Excess Lead Found in Drinking Water, July 2016. <https://www.legco.gov.hk/yr15-16/english/hc/papers/hc20160711cb2-1866-1-e.pdf>
18. Midwest biodiesel plant, EPA consent agreement and final order, July 2026. https://yosemite.epa.gov/oa/EAB_Web_Docket.nsf/4d60a7db00f72aa685258e06006de32c/c750344ffbaadac285258e44005e9da4!OpenDocument
19. California refineries, California Air Resources Board settlements, 2017 and 2019. <https://ww2.arb.ca.gov/chevron-products-company-settlement-2017> ; <https://ww2.arb.ca.gov/chevron-products-company-settlement-july-2019> ; <https://ww2.arb.ca.gov/node/7342>
20. Mercuria Energy Trading SA v Onex DMCC [2026] EWHC 130 (Comm). <https://caselaw.nationalarchives.gov.uk/ewhc/comm/2026/130>

21. Druzhba pipeline, 2019: Reuters via BusinessDay. <https://www.businessday.co.za/bd/companies/2019-07-17-russian-firm-accused-of-selling-tainted-oil/> ; contamination levels, Moscow Times. <https://www.themoscowtimes.com/2019/05/06/russia-s-oil-flows-to-europe-drop-amid-contamination> ; Transneft reserve, Interfax. <https://www.interfax.ru/business/753965> ; claims up to \$1 billion (Reuters sources, via OilPrice). <https://oilprice.com/Latest-Energy-News/World-News/Russian-Pipeline-Owner-Faces-1B-Claims-Over-Tainted-Oil.amp.html> ; Belneftekhim's losses (BelTA, via a Belarus regional government site). <https://volozhin.gov.by/en/novosti-oblasti/item/6255-lost-earnings-from-selling-belarusian-oil-products-estimated-at-100m>
22. Bradken Inc., US Department of Justice, June 2020 and February 2022. <https://www.justice.gov/usao-wdwa/pr/bradken-in-c-pays-108-million-settle-false-claims-act-allegations-and-enters-deferred> ; <https://www.justice.gov/usao-wdwa/pr/former-lab-director-sentenced-prison-falsifying-results-steel-testing-parts-navy-sub>
23. California drinking-water lab, State Water Resources Control Board (ELAP) citation, April 2023. https://water.waterboards.ca.gov/drinking_water/certlic/labs/documents/lab_enforcement/eurofin_cite.pdf
24. KYB Corporation: Reuters via Arab News, October 2018. <https://www.arabnews.com/node/1390326/world> ; warranty provision. https://www.bridge-salon.jp/report_bridge/archives/eng/7242/20190717.html
25. FAA Safety Alert for Operators 18015. https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/SAFO18015R1.pdf
26. ČEZ, Dukovany nuclear plant: weld X-rays and losses for 2015, oEnergetice, February 2016. <https://oenergetice.cz/elektrina/nekvalitni-snimky-svaru-zpusobily-cez-zraty-2-a-pul-miliardy-korun> ; ČEZ results presentation, November 2015. https://www.cez.cz/webpublic/file/edee/ospol/fileexport-s/pro-investory/informacni-povinnost-emitenta/2015-11/cez-033-2015_en_i9ow4dtlfewhxm2.pdf
27. Error rates: Plebani M, Carraro P. Clinical Chemistry 1997;43:1348. <https://doi.org/10.1093/clinchem/43.8.1348> ; Hong MKH et al. BMJ Open 2013;3:e002406. <https://bmjopen.bmj.com/content/3/5/e002406> ; Mays JA, Mathias PC. JAMIA 2019;26(3):269. <https://academic.oup.com/jamia/article/26/3/269/5287977> ; Barchard KA, Pace LA. Computers in Human Behavior 2011;27:1834. <https://doi.org/10.1016/j.chb.2011.04.004> (abstract: https://online210.psych.wisc.edu/wp-content/uploads/PSY-210_Unit_Materials/PSY-210_Unit05_Materials/Barchard_abstract_CHB_2011.pdf) ; Panko R. EuSpRIG 2015. <https://arxiv.org/abs/1602.02601> ; Royal Society of Chemistry, Analytical Methods Committee Technical Brief 56, 2013. <https://pubs.rsc.org/en/content/articlehtml/2013/ay/c3ay90035e>
28. Sabine Industrial, Why LIMS Get Replaced (the first study in this series), 2026.

The full case workbook, with all 100 cases and sources, is available on request.

`sabineindustrial.com/research/what-a-lab-data-error-costs`