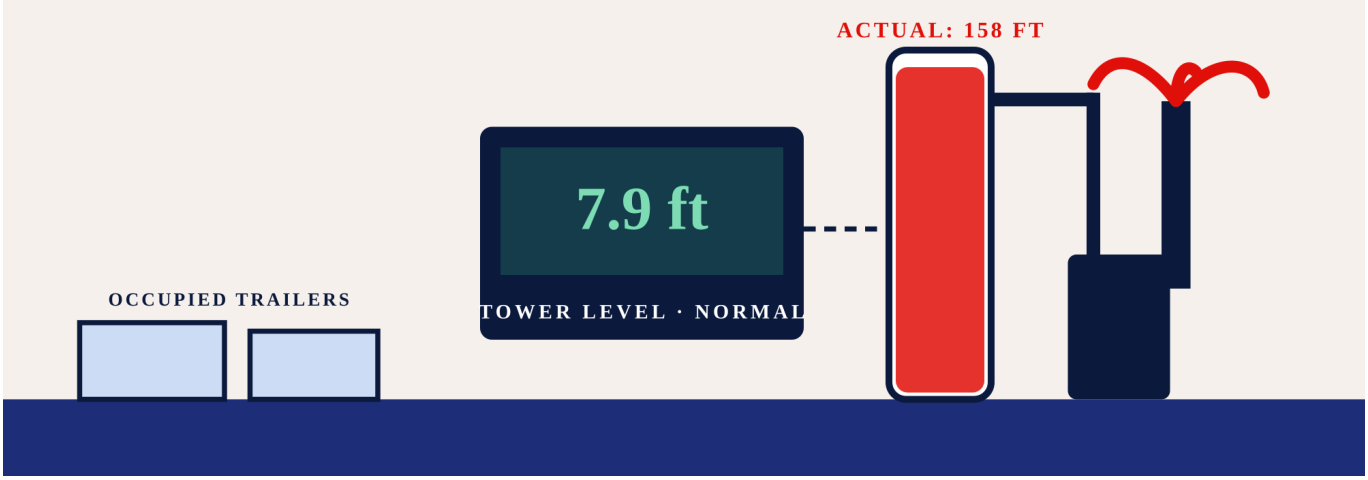


Texas City, 2005: when the instruments lied and the numbers looked good

A reliability and asset management reading of the BP refinery explosion, with five practical checks for operators

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ABSTRACT

On 23 March 2005 explosions and fires at the BP Texas City refinery killed 15 workers and injured 180 [1]. During the startup of an isomerization unit, a distillation tower was overfilled for hours while its level instrument showed a normal reading. Relief valves discharged into an atmospheric blowdown drum and stack, liquid geysered out, and the vapour cloud ignited [1]. We review the case with a bow-tie view, a contributing-factor map, RCM and an ISO 55001:2024 lens, and turn it into five checks.

KEY FINDINGS

1. Startup was authorised despite known faults in the tower level transmitter and high-level alarms [1].
2. Overfill drove relief discharge into an atmospheric blowdown system; the tower had no automatic high-level shutdown [1][5].
3. Occupied trailers were sited as close as 121 ft from the blowdown drum [1].
4. Low personal injury rates were read as evidence of good process safety [1][2][3].

The CSB described the event as one of the worst industrial disasters in recent U.S. history [1]. All 15 who died were contractors working in and around temporary trailers [1].

01 Context and purpose

Texas City was one of the largest refineries in the United States. BP acquired it in the 1999 merger with Amoco [1]. The accident happened in the isomerization (ISOM) unit, in a section called the raffinate splitter: a 170-ft distillation tower with a furnace, relief valves and a blowdown drum and stack that vented to atmosphere [1].

About this brief. A practitioner interpretation from public sources by AFDARA & Co.; not legal or engineering advice, not peer-reviewed. Figures, evidence check and indicators are AFDARA tools, not taken from the CSB report.

02 The sequence

At 02:15 the night lead operator began filling the tower. The level control valve that sends liquid to storage was closed, so liquid came in but none went out [1]. The tower's high-level alarm sounded at 03:09, at 72% of the transmitter range; a separate, redundant high-level switch did not sound [1].

The day shift continued the startup. The level transmitter showed a level that slowly fell, while the real level kept rising. At 13:04 the liquid stood at about 158 ft in the 170-ft

tower; the board showed 7.9 ft [1]. Flow out of the tower began only at 12:59 [1].

At 13:14 tower pressure reached 63 psig and all three relief valves opened into the blowdown drum. The drum overfilled and liquid geysered from the vent stack. The relief valves opened as designed under overpressure; the unsafe outcome came from the overfill, the limited disposal capacity and the atmospheric release path. The vapour cloud most probably ignited from an idling diesel pickup truck about 25 ft from the drum [1].

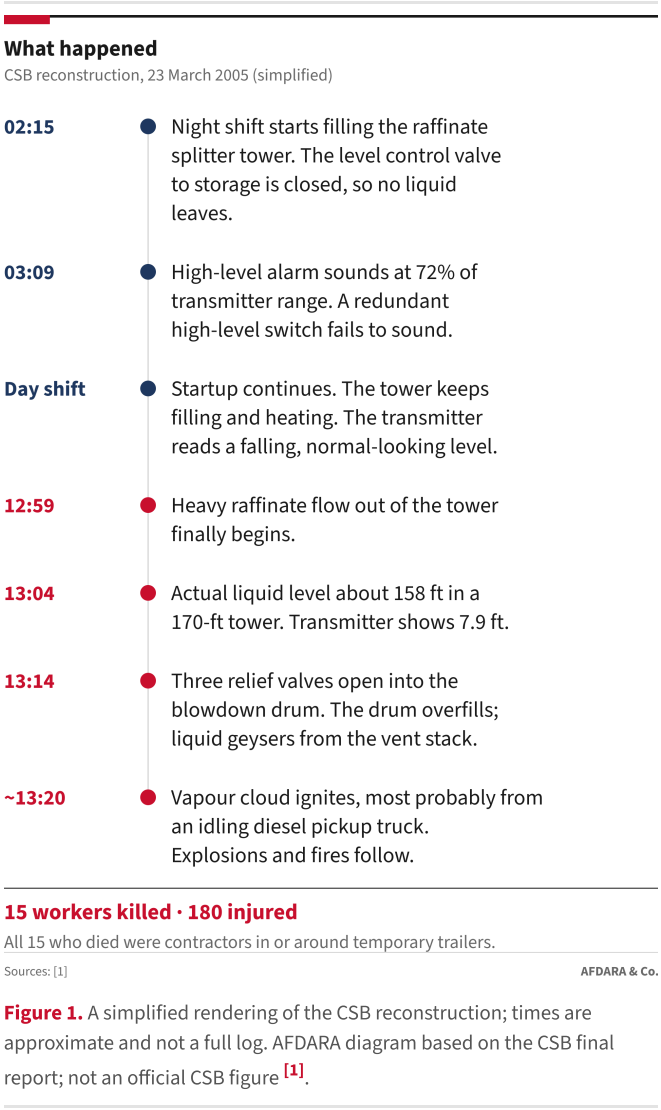


Figure 1. A simplified rendering of the CSB reconstruction; times are approximate and not a full log. AFDARA diagram based on the CSB final report; not an official CSB figure [1].

03 Reliability and barrier analysis

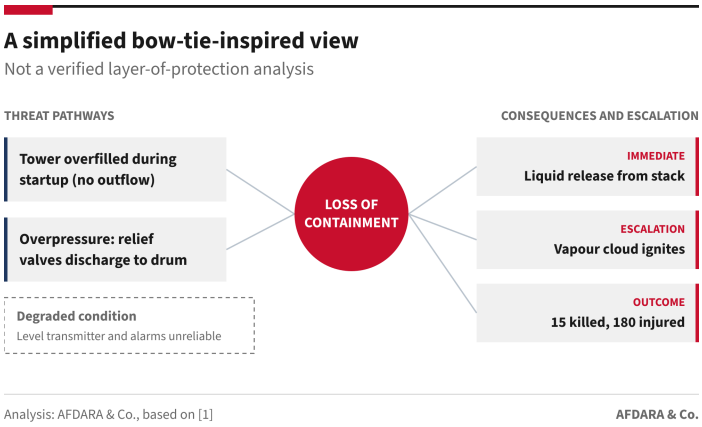


Figure 2. A qualitative cause–consequence sketch, not a safety-case demonstration, LOPA or QRA [14]. Controls that failed or were unavailable: *prevention* — reliable level indication, independent high-level alarm, an automatic high-level trip (none fitted), startup procedure and supervision; *mitigation* — relief disposal to a flare rather than to atmosphere, siting of occupied buildings away from the unit, control of vehicles and ignition sources [1][5][7].

The instruments were known to be unreliable. A work order signed on 10 March recorded that the tower level transmitter needed attention, and problems with the high-level alarms on the tower and the blowdown drum were known before the startup was authorised [1]. None of the instruments that showed the tower level worked properly on the day [1].

The disposal system was the weak point. The blowdown drum and stack discharged directly to atmosphere. In 1992 OSHA cited a similar blowdown drum at the refinery as unsafe; the citation was dropped and the drum was not connected to a flare [5]. The final CSB report documented eight serious ISOM blowdown incidents from 1994 to 2004; its 2005 preliminary findings had highlighted four other serious releases from 1995 onward [1][5].

The exposure was a choice. Temporary trailers used by contractors had been placed as close as 121 ft from the blowdown drum. All 15 fatalities occurred in or near them [1].

04 Contributing causes and organisational learning

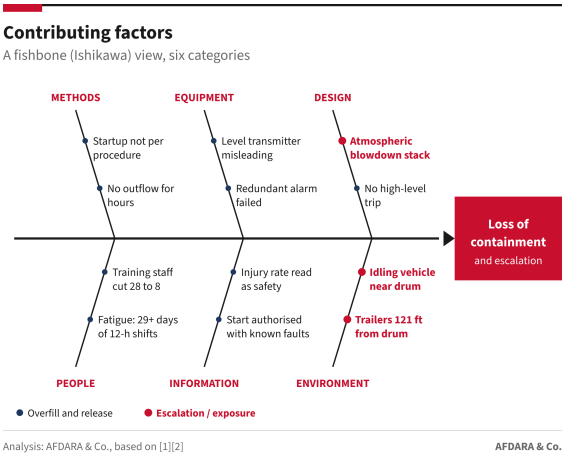


Figure 3. A workshop aid by AFDARA & Co.: a contributing-factor map for structuring discussion. It is a practitioner interpretation, not the CSB's causal analysis [1][2].

One selected branch (workshop aid). Why did the tower overfill? Liquid came in but none went out. Why was it not noticed? The level instrument showed a normal reading and a redundant alarm failed. Why were faulty instruments in service? Startup was authorised despite known problems [1][6]. Real causation had several branches.

Recorded signals. Most previous ISOM startups had seen high liquid levels in the splitter tower; the CSB reviewed 19 startups from 2000 to 2005 [1]. Operators were likely fatigued from 12-hour shifts for 29 or more consecutive days [1]. The CSB also recorded budget-cut targets of 25% in 1999 and another 25% in 2005, and a central training department reduced from 28 staff to eight [1].

The wrong gauge. BP relied on a low personal injury rate as a safety indicator; the CSB found this did not give a true picture of process safety [1]. The Baker Panel reached a similar view across BP's U.S. refineries [2][3]. Hopkins later used this as a central example of why injury rates and process safety indicators must be kept apart [10].

RCM QUESTION	APPLIED TO THE TOWER LEVEL PROTECTION
1 Function	Show tower level and warn on high level.
2 Functional failure	Shows a normal level while the tower is overfilling.
3 Failure mode	Transmitter reading misleading at high level; redundant high-level switch fails to sound.
4 Effect	Board operator sees a falling level; no alarm prompts action.
5 Consequence	Hidden failure: exposure to overfill, relief and release with safety consequences.
6 Proactive task	Calibration and functional test of level instruments before every startup.
7 If no proactive task	Redesign may be required: for example an independent high-level trip, specified under a recognised functional-safety process [13].
Operational rule	Separately: no startup while safety-critical instruments are known to be faulty, unless site-approved risk controls authorise it.

Table 1. RCM questions (after SAE JA1011 [12]; not a quotation), applied by AFDARA & Co. to the tower level protection described by the CSB [1]. The pre-startup test is an AFDARA example to be set by site risk assessment; JA1011 does not prescribe a test frequency.

> **TAKEAWAY**
> Treat startup as a high-risk mode: verify instruments, staff it properly, and keep people away from the unit.

05 A retrospective ISO 55001 lens

Viewed retrospectively through ISO 55001:2024, the case raises questions about risk, change, competence, operational control and performance evaluation. These are illustrative questions, not a historical audit or a finding of nonconformity. ISO 55001 did not exist in 2005 and complements rather than replaces process-safety and legal requirements [4]. The CSB recommendations helped prompt later industry guidance, including API practices on portable-building siting, process-safety indicators and fatigue [7][8][9].

HISTORICAL CONTROL ISSUE IN THIS BRIEF	ILLUSTRATIVE ISO 55001:2024 QUESTION TODAY
Startup authorised with faulty instruments	6.1 Actions to address risks · 8.1 Operational planning and control
Trailers placed near a hazardous unit	6.3 Planning of changes · 8.2 Control of change
Long shifts; training capacity cut	7.1 Resources · 7.2 Competence
Injury rate used as the safety measure	9.1 Monitoring, measurement, analysis and evaluation
Repeated blowdown stack releases	10.2 Nonconformity and corrective action

Table 2. Selected illustrative mappings [4]. The clauses do not prescribe a specific instrument test, siting rule or indicator set.

06 A startup-state screen

CONDITION	POSSIBLE EFFECT	SAFER ACTION
Safety-critical instrument known faulty at startup	Operators act on false information	Pre-startup instrument check; defer startup or approve compensating measures
Feed in, no product out	Overfill of column or vessel	Mass-balance check by shift; supervisor review of level trends
Relief disposal to atmosphere on flammable service	Release and vapour cloud	Engineering review of disposal system; route to flare where required
Occupied temporary buildings near the unit	Many people exposed to blast	Siting study before placing; move people during startups
Long run of 12-hour shifts	Fatigue and missed cues	Hours limits and fatigue risk management

Table 3. Illustrative condition–effect–action screen; not a complete FMEA or hazard study. Methods and limits come from site procedures, risk assessment, legal requirements and applicable standards.

Evidence check (AFDARA heuristic). For each critical control, look for evidence that it *exists*, is *understood*, is *implemented* (sampled records and observations) and *performs* under defined conditions. Texas City had a startup procedure and alarms [1]; the gaps lay in implementation and performance.

07 Five practical checks and risk-linked monitoring

1. **Pre-startup instrument check.** Before every startup, confirm that level, pressure and alarm instruments on the safety-critical list have been tested, with records and a named approver [1][13].
2. **Mass balance during startup.** Track what goes in and what comes out of each vessel, shift by shift. A rising inventory with no outflow is a stop signal [1].
3. **Relief and disposal review.** Know where every relief valve discharges. Challenge any flammable discharge to atmosphere near people or ignition sources [1][5].
4. **People out of harm's way.** Site occupied buildings using a documented study, and control non-essential people and vehicles near units during startups [7].
5. **Measure the barriers, not just the injuries.** Keep process safety indicators separate from injury rates, and link them to the barriers that prevent major accidents [8][10][11].

Illustrative indicators

INDICATOR	DEFINITION TO SET	RESPONSE RULE
Startups with impaired safety instruments	Number of startups begun with any safety-critical instrument out of service	Management review before the next startup
Overdue instrument proof tests	Safety-critical instruments past their test date	Owner restores or approves compensating measures
People in hazard zones	Occupied portable buildings inside the siting study limits	Relocate or re-assess
Hours of work	Operators beyond the site's hours or rest limits	Fatigue review and cover
Process safety events	Tier 1 and Tier 2 events by API RP 754 definitions	Investigate and trend [8]

Thresholds and monitoring frequencies are AFDARA heuristics and must be set by site risk assessment, not read as ISO 55001 or statutory limits. For each indicator define scope, numerator and denominator, time window, owner, response and closure evidence. Indicators give early warning, not prediction [11].

QUESTION FOR YOUR TEAM

If the level on your board were wrong right now, what else would tell you?

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