

GAME DESIGN DOCUMENT

Atomic Archie

A 6×6 cluster-pays atompunk slot — an eerie, starved base game that erupts into a stacking-multiplier meltdown bonus.



GAME RTP

~94.2%

VOLATILITY

Med-High

MAX WIN

5,000×

GRID

6×6 Cluster

Designed & built by Jack Drach · jackdrach.com

Original concept, math design, Monte-Carlo validation, art direction & engineering. All figures sourced from the game's real configuration and simulation harness. Confidential design document.

1 Overview

Atomic Archie is an original 6×6 cluster-pays slot set in a 1950s atompunk wasteland, built in a flat hand-drawn cartoon style. Wins form from clusters of 4+ orthogonally-connected matching symbols; winning columns then **Powernudge** — they shift down one row, dropping the bottom symbol and dealing a fresh one on top — and re-evaluate, chaining until no new clusters form. The design philosophy is a lean, suspenseful base game whose return is carried by a single escalating bonus: **Meltdown Mode**, where dropped warheads stack radiation multipliers on the grid until a cell goes critical and the whole field detonates.

THE HOOK

One bonus, one rising threat. In **Meltdown Mode**, each warhead lays a diamond of stacking multipliers on the board; overlapping blasts add together and cells cool over time. When any cell's radiation reaches critical (44), the entire field detonates for a combined payout. The tension is whether fresh warheads re-heat the board — or push a cell over the edge — before the multipliers decay. The bonus is buyable at 110×, priced to a ~95% buy RTP.

ATTRIBUTE	VALUE
Title	Atomic Archie
Grid / mechanic	6×6 cluster-pays (4+ orthogonal), Powernudge chain, no fixed lines
Paying symbols	8 paying (salvage tiers) + WARHEAD scatter + in-bonus warhead
Bet range	\$0.50 – \$50.00 (default \$1.00)
Theme / style	1950s atompunk wasteland · flat hand-drawn cartoon
Base game RTP (base only)	58.80%
Total game RTP (with natural trigger)	~94.2%
Volatility class	Medium-High

Max win	5,000× bet (per-bonus cap)
Engine / stack	TypeScript · PixiJS v8 · GSAP · Vite

2 Key Stats

TOTAL GAME RTP 94.2% Base line + natural trigger · 100k-bonus sim	BONUS AVERAGE 104.6× Meltdown Mode · 100k-bonus sim	BUY RTP 95.0% of the 110× buy price	MAX WIN 5,000× validated per-bonus cap
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METRIC	VALUE	VALIDATION
Total game RTP	~94.2%	100k-bonus Monte-Carlo, sim & engine matched
Base-only RTP	58.80%	500k-spin sim, SIZE_TRIM-independent
Natural bonus trigger rate	~1 in 296	3+ scatters on a base spin (analytic + sim)
In-bonus retrigger rate	5.80% / spin	count-on-appearance rule (100k-bonus sim)
Bonus average payout	104.6×	100k-bonus sim (engine 105.6×, within noise)
Buy RTP @ 110×	95.05%	bonus avg ÷ buy price
Avg spins per bonus	11.24	incl. retriggers (100k-bonus sim)
Bonus zero-pay rate	0.04%	effectively never a dud
Win caps (5000× / nudge / spin)	0.00% each	all caps confirmed dead at current tuning

3 Core Mechanics

Base Spin, Clusters & Pownudge

Each spin fills the 6×6 grid from weighted pools. A cluster is 4 or more identical paying symbols connected orthogonally (up/down/left/right, no diagonals); each cluster pays once as a group, valued as the symbol's base pay × a size factor that scales with cluster size. After paying, every column that contained a winning symbol

Pownudges: the column shifts down one row, the bottom symbol drops off, and one fresh symbol enters at the top. The board re-evaluates and the chain repeats until no clusters form. This is a nudge, not a full tumble — only winning columns move, and only by one row per step.

Paytable & Symbol Ranking

Eight salvage symbols rank high-to-low; rarer symbols pay more. Cluster pay = base value × size factor, so larger clusters escalate the payout on the same curve.

SYMBOL	TIER	BASE PAY	RARITY
Bottlecap	1 (high)	1.00	Rarest
Medkit	2	0.85	
Battery	3	0.70	
Can	4	0.50	
Boot	5	0.40	
Tire	6	0.30	
Scrap	7	0.25	
Rubble	8 (low)	0.20	Most common
WARHEAD (scatter)	Trigger	—	3+ triggers Meltdown Mode

Base pay is × bet, before the size factor. The base-game size curve runs from 0.27× (size 4–5) up to 6.62× (size 15+), tuned via a locked linear trim so the base game returns 58.80% on its own.

Scatter & Trigger

The WARHEAD scatter is a non-paying trefoil badge that never forms or joins a cluster. Landing 3 or more scatters on a base spin triggers Meltdown Mode (~1 in 296 spins). Critically, scatters are counted **on appearance** — the trigger fires the instant a third scatter is on the board at any point in the Pownudge chain, before nudging can drop one off. The same rule governs in-bonus retriggers.

DESIGN NOTE — COUNT-ON-APPEARANCE

An earlier settled-board rule counted scatters only after the nudge chain finished. Because scatters are ordinary nudgeable symbols, a player could see three scatters that then nudged off before the count — a "saw three, got nothing" moment on ~1 in 6.4 bonuses. The fix counts the peak scatter presence during the spin, making the trigger reliable; the bonus size curve was then re-tuned to hold the RTP at ~94.2%.

4 Bonus Feature — Meltdown Mode

Meltdown Mode is an 8-spin feature (before retriggers) played on a persistent radiation field. Spin 1 always drops a warhead; spins 2–8 each have a 40% chance to drop one. A warhead lays a multiplier gradient by distance from ground zero — a diamond of radius 2 with ring values 18 / 9 / 4. Overlapping warheads **add** their ring values to a cell's base, and after each drop the whole field refreshes to full strength. A winning cluster takes the highest multiplier of any hot cell it covers.

Decay & The Meltdown

Multipliers cool over the nudge chain: after a 12-step grace period, each hot cell loses strength on a ramp until it goes cold. This bounds the field so it cannot accumulate indefinitely. The climax is the **meltdown**: when any cell's base radiation reaches the critical threshold of **44** (reached by overlapping warheads), the entire live field sums and pays out at a 0.85 factor, then clears cold. A meltdown is signalled by a full-board warhead bombardment, a crater that consumes the board, and a dedicated MELTDOWN WIN payout reveal.

PARAMETER	VALUE	NOTE
Free spins	8	before retriggers
Spin-1 warhead	Guaranteed	40% chance on spins 2–8
Ring multipliers	18 / 9 / 4	by Manhattan distance, radius 2
Overlap behaviour	Additive	stacked warheads sum on a cell
Meltdown threshold	44	cell base radiation goes critical
Meltdown payout	field sum × 0.85	then the field clears cold
Retrigger	+5 spins	3+ scatters, count-on-appearance
Value split	~61% cluster / ~39% meltdown	of total bonus value

VALIDATED — MELTDOWN MODE

Bonus average 104.6× · buy RTP 95.05% at the 110× buy price · retrigger rate 5.80% per spin · 11.24 avg spins per bonus · 0.04% zero-pay · all win caps dead. Engine verified against the sim over 100k bonuses (retrigger 5.81%, bonus avg 105.6× — within Monte-Carlo noise).

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The whole game was tuned against a Python Monte-Carlo harness that runs the real game logic — not an abstract spreadsheet. The simulator mirrors the engine's weights, payout code, field mechanics and retrigger rule exactly; whenever the two diverged, the engine was treated as source of truth and the sim corrected to match, then re-tuned. Every headline figure below comes from that harness, and the shipped engine was independently re-verified against it.

RTP Composition

`<font face='Courier'>// total game RTP — how the ~94.2% is composed</font>`

`<font face='Courier'>TOTAL = base_only(58.80%)</font>`

`<font face='Courier'>          &+ natural_trigger_rate(1/296) × bonus_avg(104.6×)    &≈ 35.4%</font>`

`<font face='Courier'>         &≈ 94.2%    &(computed from the measured bonus RTP)</font>`

Key Tuning Levers (in order of leverage)

LEVER	EFFECT
Bonus SIZE_TRIM	Primary linear dial on the bonus cluster channel (~61% of bonus value). Re-tuned 0.0765 → 0.0466 to hold ~94.2% after the count-on-appearance change enriched retriggers.
Base SCATTER_WEIGHT	Sets the natural trigger rate (~1 in 296). Each natural trigger is worth ~104.6×, so it moves total RTP quickly.
Ring multipliers & threshold	18/9/4 and the 44 critical threshold set how readily overlaps push a cell to meltdown, splitting value between the cluster and meltdown channels (~61/39).
Decay ramp & grace	Bounds field accumulation so multipliers can't run away across a long nudge chain.

Problems Solved During Tuning

THE RETRIGGER BUG. Playtesting revealed 3 scatters in the bonus sometimes did nothing. Diagnosis with a headless harness proved scatters were nudging off the board before a settled-board count — a bug on ~1.7% of spins that a 50k exhaustive test had "passed" because the test validated the wrong rule. The structural fix (count-on-appearance) makes it impossible to show 3 scatters and not retrigger; the bonus trim was re-tuned in the sim and re-reported to the engine, both re-verified.

THE WARHEAD CLIP. The diving-warhead animation clipped its own nose — traced to the sprite exceeding its frame bounds and, separately, being covered by the steel frame's inner lip. Fixed by keeping frame margin and re-parenting the effect into an unclipped overlay above the board — measure-first problem-solving verified numerically before eyeballing in-game.

6 Design Intent

The intended experience is an eerie, quiet base game punctuated by one escalating threat. Most base spins are calm by design, which makes a scatter trigger feel like an event — the alarm sounds, the sky fills, and the shelter doors close. Meltdown Mode is a single, legible fantasy: build the radiation, chase the critical mass, and survive the detonation for the combined payout.

The Rising Threat

Every element of the bonus reinforces one idea — the reactor going critical. The heat-stage cell art climbs from dormant to red as multipliers stack; a radiation meter needle tracks the hottest cell toward 44; and the meltdown itself is a full-board warhead bombardment that leaves a smoking crater. The player always knows how close they are to the payoff, and the decay keeps that tension live rather than a foregone conclusion.

VOLATILITY AS THEME

The medium-high volatility isn't just a math setting — it's the fiction. A calm wasteland that suddenly erupts mirrors the payout shape: long quiet stretches broken by a meltdown that can sum the whole field. The starved base and the explosive bonus are the same design statement told twice.

7 Tech & Architecture

AREA	IMPLEMENTATION
Engine / stack	TypeScript (strict) · PixiJS v8 · GSAP · Vite
Math model	Server-authoritative trace: the bonus is computed in a pure logic pass, then replayed as animation — no math runs during rendering
Single source of truth	All weights, ring values, thresholds & caps live in config; the Monte-Carlo sim mirrors them exactly
Validation	Python Monte-Carlo harness on the real game logic (100k-bonus runs); engine re-verified headless against the sim
Info screen	Data-driven rules panel — reads live from the real constants, can never drift from the math
Audio	Procedurally synthesized SFX (numpy/scipy) + state-driven music per mode; layered warhead booms for the meltdown

NOTES & SOURCING

All headline figures were audited against the live code and simulation runs. Total RTP (~94.2%), base-only RTP (58.80%), retrigger rate (5.80%), bonus average (104.6×) and buy RTP (95.05%) are all sourced from 100k–500k sim runs and confirmed against the compiled engine. The meltdown presentation (warhead swarm, crater, MELTDOWN WIN reveal) is display-only over the verified pre-computed result and does not affect the math.