OUTLOOK PAPER 01

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VITALSPEC DEFENCE INDUSTRIAL OUTLOOK 2026

Why explosive fill, propellant and LAP will define Europe's rearmament

An intelligence assessment of industrial capacity, strategic demand and the investment required to rebuild European ammunition production.

CORE JUDGEMENT

Europe has entered a defence industrial super-cycle. The question is no longer whether governments will procure ammunition; it is whether industry can expand the four constrained lanes of supply quickly enough. We assess with **high confidence** that announced public programmes — although necessary and already material — will not rebuild strategic 155 mm depth inside the threat window identified by allied governments (2029–2030) without a second wave of private and public–private industrial investment.

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BASIS PUBLIC-SOURCE ONLY SOURCES ANNEX E

§ Contents

HOW TO READ THIS PAPER

Key judgements and Sections 1–2 carry the argument; Sections 3–7 quantify it; Sections 8–11 turn it into an investment and watch-list frame. Annexes hold the workings.

SCOPE NOTE

This Outlook assesses the industrial capacity required to restore Europe's sovereign 155 mm artillery ecosystem, with particular attention to high-explosive fill, propellant manufacture, and Loading, Assembly and Packing (LAP) together with quality assurance, proof and licensed storage. It converts public policy commitments and company announcements into a single consistent model of demand, capacity and investment need.

It is not a forecast of government procurement decisions and it does not claim knowledge of classified stockpiles or undisclosed plant tonnage. Where official data does not exist, assumptions are stated explicitly, treated as planning inputs, and stress-tested in Section 10 and Annex C. The paper is built from public sources: government, EU and NATO policy documents; company announcements; and reputable reporting of contracts, permits and capacity. One deliberate exception is labelled where it occurs: the inert-body corridor economics (Section 7.1) incorporate direct supplier and freight quotations obtained commercially by VitalSpec, presented as planning inputs alongside the public contract-implied figures. Every factual claim carries a hyperlinked citation; the full source register is at Annex E. Inference is deliberately labelled as inference.

The analysis was prepared in July 2026 and reflects the public record at that date. The 155 mm production landscape is moving quickly — the EU's 2 million round annual objective, still aspirational in 2024, was reported as achieved in early 2026 — and readers should treat capacity figures as a dated snapshot, maintained through the indicator set in Section 11.

ESTIMATIVE LANGUAGE

This paper uses the probability yardstick and confidence conventions common to allied intelligence assessment. Probability terms describe the likelihood of an event; confidence levels describe the strength of the evidence base. The two are independent: a judgement can be highly likely but held at low confidence.

PROBABILITY YARDSTICK

Remote chance	≤ 5%
Highly unlikely	10–20%
Unlikely	25–35%
Realistic possibility	40–50%
Likely / probably	55–75%
Highly likely	80–90%
Almost certain	≥ 95%

CONFIDENCE LEVELS

High confidence
Multiple credible, corroborating public sources; low risk of revision

Moderate confidence
Credible sourcing with gaps; plausible alternative readings exist

Low confidence
Fragmentary or single-source evidence; treated as planning input

KJ Key judgements

1 European rearmament is structural, not a Ukraine-contingent spike

HIGH CONFIDENCE

The policy architecture now locks in multi-year demand: NATO allies committed at The Hague in June 2025 to 5% of GDP by 2035, including 3.5% for core defence and the NATO capability targets[1] [2]; the EU has mobilised up to €800 billion under Readiness 2030 and adopted the €150 billion SAFE instrument, whose first national allocations were approved in January 2026[3] [4] [5]; and the UK's June 2026 Defence Investment Plan commits £11 billion to munitions and weapons — raised from the SDR's £6 billion — including at least six new energetics factories by 2030[64] [65] [9] [10].

2 The binding constraint has shifted from projectile bodies to energetic materials and LAP

HIGH CONFIDENCE

Body and complete-round assembly capacity is scaling rapidly and visibly — Rheinmetall's €500m Unterlüss plant alone targets 350,000 rounds/year by 2027[23] [24], ZVS Snina 360,000 bodies/year[36] — while Europe's visible base for TNT, RDX and qualified propellant remains narrow, slower to expand, and partly committed outside Europe. A warehouse of inert bodies is industrial progress; it is not usable firepower.

3 Europe's TNT and RDX base is critically narrow through at least 2028–29

MODERATE CONFIDENCE

Nitro-Chem of Poland — Europe's dominant TNT producer at roughly 10,000 t/year — has committed 18,000 t to the US market across 2027–2029[13] [14] [15]. This is a window problem rather than a permanent one: Nitro-Chem is doubling capacity to ~20,000 t/year[15], SWEBAL's fully financed 4,500 t/year plant targets full output in 2028[19] [20] [21], and the US Repkon plant in Kentucky (completion February 2029) will progressively remove US demand from European supply[16] [17]. But the window coincides exactly with the years allied assessments identify as the period in which Russia could reconstitute the capability to threaten NATO[47] [56].

4 **The bottleneck finding is robust to the reserve assumption** HIGH CONFIDENCE

This paper's baseline is deliberately the number a sceptical planner concedes — a 30 million round floor triangulated from consumption data, the European barrel park and adversary output — not a strategic wish-list. Even at that floor, announced energetic-materials capacity cannot deliver the fill inside the 2029–2030 threat window: at planning-estimate output of ~10,000 t/year, producing the floor's RDX alone takes ~18 years if every tonne is allocated to European reserves and nothing to Ukraine, exports, training or proof (Figure 2). The insurance tiers (55m/90m/140m, Annex D) scale the gap; they do not create it.

5 **Precursor dependencies are an unpriced single point of failure** MODERATE CONFIDENCE

Europe relies on China for more than 70% of the cotton linters used to make nitrocellulose, on the estimate of Rheinmetall's chief executive[41], and Beijing has already restricted nitrocellulose exports and tightened dual-use controls[41] [42]. European nitroguanidine capacity for true triple-base propellant has very low public visibility and should be treated as a hidden bottleneck.

6 **A second wave of private and public–private capacity is highly likely to be required**

MODERATE CONFIDENCE

Public programmes create demand and de-risk offtake, but on our modelling they leave even the 30m baseline floor unfilled until the mid-2030s, and the insurance tiers unreachable, without capacity that is not yet financed or permitted (Section 6). The gating risks for new entrants are qualification and offtake, not demand.

7 **Demand survives a ceasefire** LIKELY

Even under a 2027 cessation of hostilities, the replenishment, sovereign-reserve and NATO capability-target layers of demand persist under contracted multi-year frameworks and treaty-level spending commitments[1] [3]. The layer most exposed to a ceasefire — direct Ukraine consumption — is also the layer current production overwhelmingly serves; its decline would accelerate, not eliminate, reserve rebuilding. The downside case is examined in Section 6.3.

01 Strategic context: rearmament has become structural

The first-order change since 2022 is not a higher order book for ammunition producers. It is a strategic reassessment of industrial depth. European governments have moved from emergency donations, spot procurement and ad hoc replacement orders towards rebuilding the capacity to sustain ammunition production during a long confrontation. The policy language has converged across institutions: bottlenecks in powder, propellants, explosives, shells and testing are now named in EU legislation; ammunition supply is treated as an alliance-level production problem; and national governments frame munitions and energetics as warfighting-readiness infrastructure.

POLICY SIGNAL	WHAT IT ESTABLISHES	SOURCE
NATO Hague Summit, June 2025	5% of GDP by 2035, of which 3.5% core defence tied to NATO capability targets; progress review in 2029	NATO [1] [2]
EU Readiness 2030 White Paper	Up to €800bn mobilised; ammunition and missiles named among priority capability gaps	European Commission [3]
EU SAFE instrument	€150bn joint-procurement lending adopted May 2025; first eight national allocations approved January 2026	Council of the EU / EC [4] [5]
EU ASAP	€500m targeted at bottlenecks in powder, propellants, explosives, shells and testing; 2m rounds/yr objective reported achieved in early 2026	European Commission [7] [8]
UK SDR 2025 → DIP 2026	£6bn munitions in SDR raised to £11bn in the June 2026 DIP; £1.5bn 'always on' pipeline; at least six new energetics factories by 2030, 13 candidate sites	UK Government [64] [65] [9] [10]
National programmes (DE, FR, PL, Nordics, CEE)	Major and frontline states expanding sovereign or allied production routes — detailed in Section 5	Various [24] [30] [32]

The threat timeline gives these commitments their urgency. Germany's Federal Intelligence Service assesses that Russia will be prepared to wage large-scale war by 2030; the Bundeswehr's Inspector General has warned of possible capability to attack NATO from 2029[56] [47]. NATO's Secretary General has said Russia could be ready to use force against the alliance within five years, and that Russia's ammunition output over three months equals a year of production for the whole of NATO[46] [45]. Estonia's foreign intelligence service estimates Russian production or refurbishment of some 7 million rounds of artillery, mortar, tank and rocket ammunition in 2025 — roughly 3.4 million of them howitzer shells — seventeen times pre-invasion levels[43] [44].

ANALYTICAL IMPLICATION

The policy shift has two consequences. First, it lowers demand risk for credible industrial capacity: the spending is treaty-anchored, legislated and contracted, not discretionary. Second, it raises execution risk, because every country is now trying to expand similar facilities, recruit similar scarce expertise, permit similar hazardous sites and secure similar feedstocks at the same time. That competition for execution capacity is itself part of the industrial problem this paper models.

02 The demand model: a floor, then insurance

Public debate on ammunition is conducted in aggregates — 'two million shells' — that hide the real industrial question. This Outlook builds demand the other way: it derives, from three independent methods, the minimum stockpile a sceptical European planner cannot argue below, adopts that floor as the baseline for every calculation in the paper, and then prices the strategic insurance tiers above it separately (Annex D). The paper's conclusions stand on the floor. The tiers describe how much bigger the problem becomes if Europe insures seriously.

2.1 Deriving the requirement: three independent methods

Rather than asserting a reserve number, the requirement is triangulated three ways. Each method is independent of the others; their convergence is what gives the floor its authority.

Method A — consumption-anchored. Observed wartime consumption provides the hardest data. Ukraine's firing rates have ranged from ~2,000 rounds/day under supply constraint to 7,000–7,500/day when supplied, with stated requirements up to ~200,000/month for offensive operations[48]. A European contingency sustained at 5,000–10,000 rounds/day alliance-wide consumes 1.8–3.7 million rounds/year. Ninety days of high-intensity operations absorbs 0.5–0.9m rounds; a single year absorbs up to ~3.7m; and a reserve intended to ride out the destruction or blockade of production in the opening phase of a peer war must cover multiple years.

Method B — barrel- and days-of-supply-anchored. European NATO members field an expanding park of modern 155 mm systems: Poland alone plans 212 K9-family guns by 2026, Finland 112, Germany's PzH 2000 fleet and successor orders, France's 109 CAESAR Mk II, plus UK, Italian, Dutch, Nordic and CEE fleets[62] [63]. A planning-level aggregate of ~2,000 modern barrels (our inference — no official total exists) firing a NATO-typical planning rate of 50–75 rounds/gun/day implies 100,000–150,000 rounds/day at full commitment. Ninety days of supply on that basis is 9–13.5m rounds for the barrel park alone — before Ukraine's needs, training, proof or attrition stocks.

Method C — adversary-benchmarked. Estonia's foreign intelligence service estimates Russia produced or refurbished ~4.5m rounds in 2024 and ~7m rounds (all natures, ~3.4m of them howitzer shells) in 2025, and is stockpiling ahead of possible confrontation with NATO[43] [44]. A Europe that intends to deter must be able to match a decade of adversary artillery output with a combination of stocks and mobilised production. A decade of Russian howitzer-shell output at current rates is ~30–40m rounds; adding refurbishment, DPRK/Iranian imports and growth pushes the benchmark toward 50m+.

METHOD	BASIS	IMPLIED EUROPEAN REQUIREMENT
A. Consumption-anchored	Observed Ukraine firing rates; 90 days to multi-year coverage	~1m (90 days) to ~18m (10 years at moderate tempo, one front)
B. Barrel / days-of-supply	~2,000 modern barrels × 50–75 rds/day × 90 DOS	~9–13.5m as a 90-day war reserve, excl. Ukraine and training
C. Adversary-benchmarked	Decade of Russian output incl. imports and growth	~30–50m+ to hold parity in depth
Triangulated floor	Convergence of A–C plus a 5–10m Ukraine reserve	**~25–40m rounds — adopted as the 30m baseline floor**

2.2 The baseline: a 30-million-round floor

This paper adopts 30 million rounds — the midpoint of the triangulated range — as the baseline requirement for every calculation that follows. It is deliberately the number a sceptical planner concedes, not the number a hawk demands: roughly 90 days of supply for the European barrel park, modest national war reserves, and a 10-million-round Ukraine deterrence reserve reflecting several years at Ukraine's constrained-supply consumption rate. It is consistent in spirit with NATO capability-target logic — days of supply, built incrementally, reviewed at the 2029 checkpoint[1] — and it is the level at which every bottleneck conclusion in this paper is already triggered. If actual residual stocks or procurement ambitions differ, the model scales linearly and transparently.

> WHAT GOVERNMENTS WILL ACTUALLY BUY
>
> We are not naive about the gap between strategic logic and fiscal behaviour. Absent a direct and proximate threat, European governments will procure toward this floor, not toward the insurance tiers: that is precisely why it is the right modelling baseline. The analytical point — and the investable one — is that even the floor exceeds what announced capacity can fill within the threat window. Rising threat perception moves procurement up the tiers; it never moves it below the floor.

2.3 The strategic insurance tiers, in summary

Above the floor sit three insurance tiers. Unlike the floor they are not predictions of procurement; they are priced answers to the question 'what would serious insurance cost?' Each is derived from a distinct planning logic with a distinct duration anchor — not from an arbitrary reserve-years multiplier. Full derivations, buyer-group composition and material conversions are at Annex D.

TIER	SIZE	STRATEGIC MEANING AND DURATION ANCHOR	VS FLOOR
Baseline floor	~30m	90 days of supply for the barrel park plus a Ukraine deterrence reserve — the compliance level (Section 2.2)	×1.0
Tier 1 — mobilisation bridge	~55m	Floor plus three years of alliance-wide war consumption (~4.5m/yr) while industry mobilises — three years being Europe's demonstrated 2022–25 ramp time	×1.8
Tier 2 — sustained defence	~90m	Floor plus a decade of adversary-matched supply (Method C) with a survivability margin for struck or dispersed stocks	×3.0
Tier 3 — continental depth	~140m	Tier 2 extended across wider NATO-Europe including Türkiye sensitivity, plus insurance against early loss of production capacity	×4.7

None of the tiers assumes parity with Russia's total legacy stockpile or simultaneous multi-front peak consumption. All are priced insurance against the scenario allied intelligence services themselves describe[47] [56]. Every conclusion in this paper that matters for policy or investment is already triggered at the floor: at 30m rounds, the RDX requirement alone absorbs ~18 years of generously-estimated European output (Figure 2). The tiers change the size of the gap, not its existence.

2.4 Existing stocks and why they are not deducted

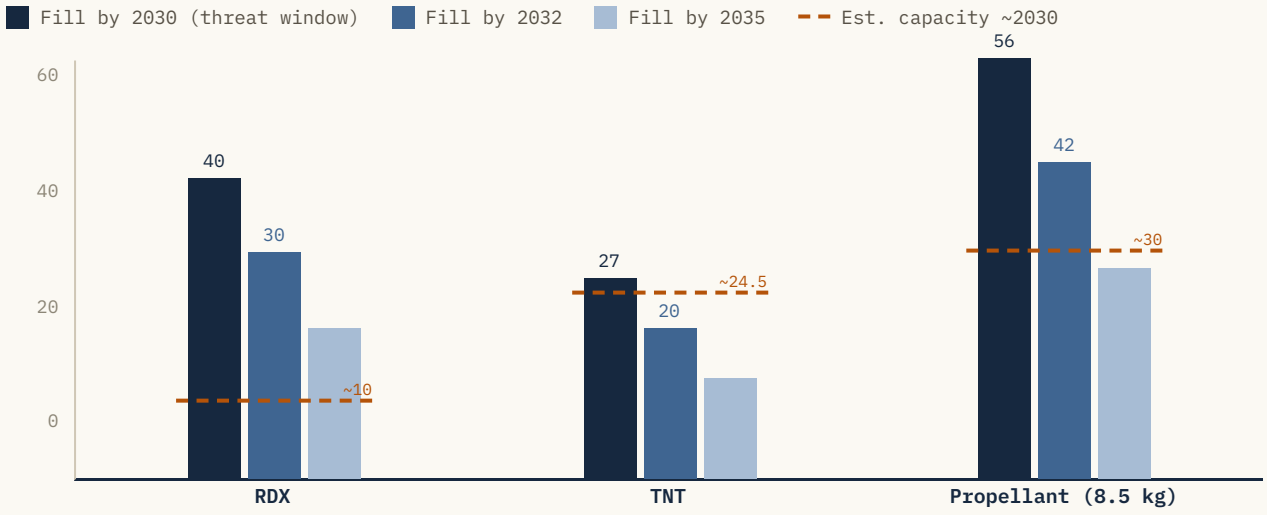
Existing national stocks are unknown and materially depleted by four years of support to Ukraine and historically thin peacetime holdings. Deducting a speculative stock number would create false precision. The Outlook therefore models requirement ranges and focuses on the annual capacity needed to rebuild depth under different timelines. If actual residual stocks are higher than assumed, the effect is equivalent to reading the model one rung lower on the ladder — where the conclusions still hold.

03 From rounds to industrial inputs

A 30m-round reserve is not 30 million steel bodies. It is demand for explosive fill, RDX, TNT, propellant, LAP throughput, QA, proof, storage and transport. Converting the baseline floor into material quantities is where the market becomes a systems problem rather than a shell-price problem — and where public capacity claims can be tested. The insurance tiers scale every line below by ×1.8, ×3.0 and ×4.7 respectively (Annex D).

30M BASELINE FLOOR	PLANNING BASIS	TOTAL REQUIREMENT	RUN-RATE TO 2032
Explosive fill	10 kg per projectile	300,000 t	50,000 t/yr
RDX	60% of fill / 6 kg per round	180,000 t	30,000 t/yr
TNT	40% of fill / 4 kg per round	120,000 t	20,000 t/yr
Propellant — central	8.5 kg per round (four modules)	255,000 t	42,500 t/yr
Propellant — high-zone	10.5 kg per round (five modules)	315,000 t	52,500 t/yr
LAP throughput	One certified round	30m rounds	5.0m rds/yr +

FIGURE 1 **Filling the 30m floor — required annual run-rates vs estimated capacity**



kt / year required, all output allocated to European reserves. Dashed lines: generous planning estimates of European capacity by ~2030 (Annex B).

3.1 Composition sensitivity: the insensitive-munitions transition

The 60/40 RDX/TNT split is a deliberately conventional planning case, and it is backward-looking in one important respect: NATO fills are migrating toward insensitive munitions (IM) formulations. The qualified US TNT replacement IMX-101 — fielded in the 155 mm M795 — contains no TNT or RDX at all; it is built on DNAN, nitroguanidine and NTO[53] [54]. If Europe's next-generation fills follow this path at scale, demand shifts partly from TNT/RDX toward NTO, DNAN and NQ — materials with even narrower European supply bases (Chemring Nobel is one of very few visible NTO producers[26] [28]). The IM transition therefore changes which energetic molecules are scarce; it does not change the finding that energetic materials are the constraint. Investors should read the RDX/TNT case as the floor of the energetics opportunity, not its ceiling.

> BENCHMARK CALCULATION
>
> Filling the 30m baseline floor by 2032 requires ~30,000 t/yr of RDX — three times Europe's generously-estimated output — 20,000 t/yr of TNT against a base partly committed outside Europe until 2029, 42,500–52,500 t/yr of propellant against ~30,000 t/yr of estimated capacity, and LAP throughput of 5m rounds/yr on top of ~2.5m/yr of active demand. For scale: Rheinmetall's announced RDX expansion — the largest publicly disclosed in Europe — is 3,000 t/yr[22], one-tenth of the floor's run-rate alone. Europe's entire visible TNT base, after Nitro-Chem's doubling and SWEBAL's new plant, will be roughly 24,500 t/yr by ~2029[15] [20] — before export commitments, air-delivered munitions, other calibres and Ukraine's direct needs consume any of it. The insurance tiers multiply every figure here by up to ×4.7.

04 The four bottleneck lanes — and the constraints beside them

Strategic availability is a systems outcome. Europe must simultaneously produce projectile bodies, source explosive fill, manufacture modular propellant, and load, certify and store complete rounds. The slowest lane determines military availability.

LANE	WHAT IT PRODUCES	CURRENT ASSESSMENT	READING
Projectile bodies	Forged / machined shell bodies	Expanding quickly and visibly — important but not the hardest constraint	Necessary; more replicable than energetics
High-explosive fill	TNT, RDX, RDX/TNT and IM compositions	**Severe bottleneck;** narrow public base and export leakage during 2027–29 window	Highest strategic leverage per tonne
Propelling charges	NC/NG/NQ-based propellant and modular charges	**Severe bottleneck;** better funded publicly than fill	High barrier; qualification lock-in
LAP / QA / storage	Loading, assembly, inspection, proof, packaging, magazines	Understated bottleneck; the gate between inputs and certified ammunition	Fastest route to finished-round value

4.1 Projectile bodies: visible, important, not sufficient

Projectile manufacture requires steel supply, forging, machining, heat treatment, banding, base-bleed subcomponents, coating, QA and proof — none of it trivial. But the public evidence is unambiguous that this lane scales fastest: Rheinmetall's Unterlüss plant was built in 15 months to a 350,000 round/yr target[23] [24]; ZVS Snina reached 360,000 bodies/yr for ~€80m of cumulative investment[36]; Mesko is investing toward 150,000 rounds/yr at Kraśnik by 2027 within a >2.4bn złoty Polish national programme[32] [33]; and KNDS France has proposed lines to meet Poland's 200,000/yr goal[37]. Standalone body capacity is consequently the weakest investment position in the chain: the producer remains dependent on scarce fill, charges and LAP controlled by others.

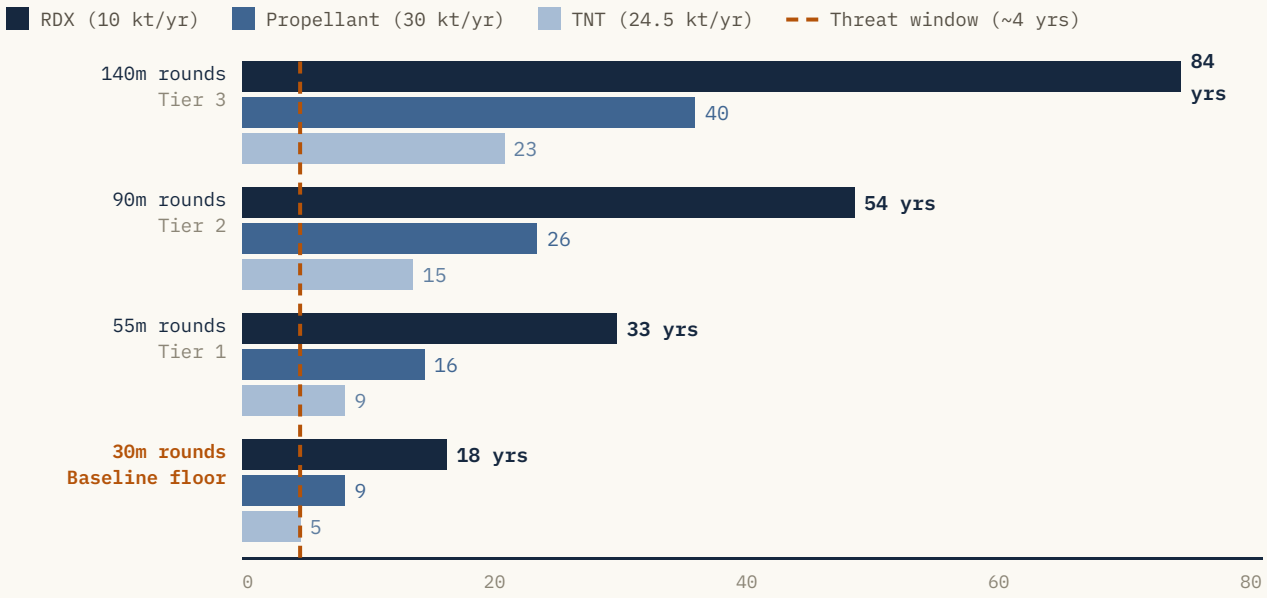
> ADVERSARIAL VIEW
>
> The risk is not that Europe cannot make shell bodies. The risk is that body capacity becomes a political comfort blanket. Several publicly celebrated 'ammunition plants' are, on close reading, body or assembly plants whose output depends on energetic materials produced elsewhere — often by exactly one or two suppliers. Announced round-count capacity should never be cited without asking where the fill and charges come from.

4.2 High-explosive fill: the under-modelled constraint

Europe's visible TNT base is exceptionally narrow. Nitro-Chem (Bydgoszcz, Poland) is repeatedly identified in public reporting as Europe's dominant producer, at roughly 10,000 t/yr[13] [15]. Its largest-ever contract — 18,000 t across 2027–2029, worth ~$310m, supplied via a US intermediary to General Dynamics for US 155 mm and aerial-bomb programmes[13] [14] — should be modelled as export leakage from the European rebuild during precisely the highest-risk years. Two developments bound this window: Nitro-Chem's announced doubling to ~20,000 t/yr on a new line[15], and the US Army's $404m Repkon plant in Kentucky, its first domestic TNT source since the 1980s, with completion set for February 2029[16] [17] [18]. From ~2029, US demand on European TNT should recede materially. Until then, Europe's TNT margin is thin: SWEBAL's 4,500 t/yr plant at Nora, Sweden — Europe's first new TNT plant since the 1990s, now permitted, financed and under construction — targets full output in 2028[19] [20] [21].

On RDX, Rheinmetall's disclosed 3,000 t/yr expansion from 2026[22] supports ~500,000 shells/yr under the 6 kg planning case. Chemring Nobel (Sætre, Norway) — one of only two European manufacturers of advanced military explosives — is more than doubling output with £32m of Norwegian and EU co-funding and studying a wholly new facility with the Norwegian government[6] [26] [27], and has anchored a long-term supply agreement with Northrop Grumman[28], but tonnage remains undisclosed. Poland's Nitro-Chem and PROZAP signed a design agreement in November 2025 for a new RDX — and potentially HMX — production facility[34] [35]. These are important moves. None of them, individually or collectively, approaches the ~30,000 t/yr needed to fill even the baseline floor by 2032; the insurance tiers require between 33 and 84 years of output at generous capacity estimates (Figure 2).

FIGURE 2 Years of European output required for reserve fill alone



Assumes 100% of output allocated to European reserves — no Ukraine supply, exports, training or proof. Even the baseline floor breaks the threat window on RDX. Capacity estimates: Annex B, D.

4.3 Propellant: visible, funded, still structurally constrained

Modern modular charges require NC/NG/NQ feedstocks, formulation, extrusion, drying, stabilisation, ballistic testing and qualification; triple-base propellant is a qualified ballistic product tied to specific guns and firing tables, not merely a chemical output. The public funding wave is real: France committed ~$540m to relocate and expand Eurenco's large-calibre propellant capacity at Bergerac, where nitrocellulose production has been restarted and the first new powder line entered service in January 2025[29] [30] [31]; Rheinmetall's Victoria (Romania) joint venture — >€500m for ~300,000 modular charges/yr from 2028, within a group goal of 20,000 t/yr of powder by 2030[25] — is the largest single addition. At 8.5 kg per round, a 4,500 t/yr propellant facility supports ~529,000 rounds/yr; at 10.5 kg, ~429,000. Filling the baseline floor by 2032 needs 42,500–52,500 t/yr; the insurance tiers need up to 147,000 t/yr (Annex D).

Propellant is attractive because it is recurring, qualification-heavy and difficult to substitute once accepted into an ammunition family. It is also slow, expensive and best suited to sovereign-backed offtake unless a project already has site, permits, technology and buyers aligned. It is treated in this Outlook as a strategic second-wave or PPP asset.

4.4 LAP, QA and storage: the conversion bottleneck

No round becomes usable military capability until it is safely filled, assembled, inspected, proofed, packaged and stored under licence. LAP has lower chemical-synthesis complexity than RDX, TNT or propellant production, but it remains regulated explosives infrastructure: safety distances, remote or automated handling, blast-protected structures, contamination management, QA laboratories, magazines, secure perimeter, specialist workforce and documented quality systems.

OBJECTIVE (INCL. 2.5M/YR ACTIVE DEMAND)	ROUNDS/YR REQUIRED	AT 200K	AT 350K	AT 500K
Baseline floor filled by 2035	5.8m	29	17	12
Baseline floor filled by 2032	7.5m	38	22	15
Tier 2 (90m) filled by 2040	8.9m	45	26	18

These site counts exclude Ukraine support during the rebuild, training, proof expenditure, export leakage, downtime and rejected lots; practical requirements are higher. BAE Systems' Glascoed and Washington sites should be counted as UK filling, component and ammunition-throughput nodes — not as evidence of UK base-explosive synthesis. BAE's new Glascoed filling facility, operational from summer 2025, delivers a sixteen-fold increase in UK 155 mm capacity on ~£150m of investment since 2022[38], which demonstrates both how much conversion capacity was previously missing and how fast LAP can scale when feedstock exists.

4.5 Adjacent constraints: scoped, not ignored

Four constraints sit outside the four-lane model but bear directly on usable capability. They are scoped here so the model's boundaries are explicit.

CONSTRAINT	ASSESSMENT	TREATMENT IN THIS OUTLOOK
Fuzes and initiation	A complete round needs a fuze, primer and igniter. European fuze capacity is concentrated in few suppliers; Junghans alone holds 10-year framework contracts including up to 420,000 multi-option artillery fuzes[51]. A genuine constraint on complete-round output.	Excluded from the four-lane model; flagged as a diligence item for any LAP investment case
Gun barrels	155 mm barrels wear out at roughly 1,500–2,500 equivalent full charges; firing a large reserve requires barrel production from a very small European forging base — the UK's new barrel line will draw steel from Sheffield Forgemasters[52]. Arguably a harder long-run bottleneck than shells.	Out of scope; noted as a parallel investment theme
Precursor chemicals	Nitric/sulphuric acid capacity, hexamine, toluene, glycerine and above all cotton linters and nitroguanidine. Europe depends on China for >70% of cotton linters (Rheinmetall CEO estimate) and China has restricted nitrocellulose exports since 2024[41] [42].	Treated as a cross-cutting risk multiplier on the propellant lane
Workforce and permitting	Every producer is simultaneously recruiting scarce energetics chemists, process engineers and licensed explosives workers, and permitting similar hazardous sites. Timeline risk on every announced project.	Reflected in the use of announced-capacity ranges rather than nameplate figures

THE CHINA DEPENDENCY, STATED PLAINLY

The most consequential un-modelled risk in European rearmament is upstream of every propellant plant: nitrocellulose feedstock. Europe's military nitrocellulose demand is estimated at ~20,000 t/yr with a shortfall estimate as high as 10,000 t; China supplies the large majority of cotton linters and has demonstrated willingness to restrict exports[41] [42]. Nitroguanidine — required for true triple-base propellant and for IM fills such as IMX-101 — has very low visible European capacity and similar China exposure. BAE's continuous-flow synthetic route, which removes the need for nitrocellulose and nitroglycerine entirely, is the most strategically interesting mitigation on the public record[39] [40], but is not yet proven at scale. Any propellant investment thesis must price this dependency; any energetics campus that internalises feedstock resilience earns a strategic premium.

05 The supply base: who actually makes what

The highest-risk error in capacity analysis is assigning base-explosive synthesis to any prime that produces ammunition. A company may synthesise energetic molecules, formulate compositions, perform filling, assemble rounds, or only manufacture bodies. Each role has different strategic value, and public announcements routinely blur them. The table below assigns model treatment; the full facility map with locations and citations is at Annex A.

COMPANY / ECOSYSTEM	PUBLIC ROLE	MODEL TREATMENT
Nitro-Chem / PGZ (PL)	Europe's dominant TNT producer (~10,000 t/yr, doubling); filling services; new RDX/HMX facility in design	Major TNT node; apply 2027–29 export-leakage sensitivity; RDX/HMX as planned, not current
Rheinmetall (DE/HU/RO/ES)	Shells (Unterlüss 350k/yr), 3,000 t/yr RDX from 2026, 1.5m propellant modules, Victoria propellant JV	Count RDX, propellant and rounds in separate lanes; not all output open-market
Chemring Nobel (NO)	Advanced explosives: RDX, HMX, NTO; doubling with EU/Norwegian co-funding; new facility under study	Major advanced-HE node; confirmed role, undisclosed tonnage — no invented figures
Eurenco (FR/SE/BE)	Large-calibre propellant, NC restart at Bergerac, modular charges; €500m group investment programme	Propellant-chain anchor; not a shell-fill proxy
BAE Systems (UK)	Filling/LAP at Glascoed (16× uplift), components at Washington; NC/NG-free propellant R&D	LAP/throughput node; no confirmed UK RDX/TNT synthesis; R&D route strategically significant
SWEBAL (SE)	New-entrant 4,500 t/yr TNT plant, financed, construction 2026, full output 2028	Planned TNT relief from 2028; proof that private new-entry is viable
CSG / MSM / ZVS (CZ/SK/DE)	Bodies at Snina (360k/yr), NC via Walsrode, charge initiatives	Count bodies and NC separately; avoid double-counting
KNDS / Nexter (FR/BE/PL)	Ammunition systems, integration, proposed Polish 200k/yr lines	Projectile/LAP ecosystem; energetics via Eurenco and partners
PGZ / Mesko / Dezamet (PL)	155 mm rounds toward 150k/yr at Kraśnik by 2027 within >2.4bn PLN national programme	Body/round lane; energetics dependency remains
Nammo (NO/FI/SE)	Nordic ammunition and propellant network; ASAP-supported expansion	Major node; limited tonnage transparency
Junghans & fuze suppliers (DE)	Artillery fuze frameworks incl. up to 420k MOFA units over 10 years	Initiation lane — outside four-lane model, tracked as constraint

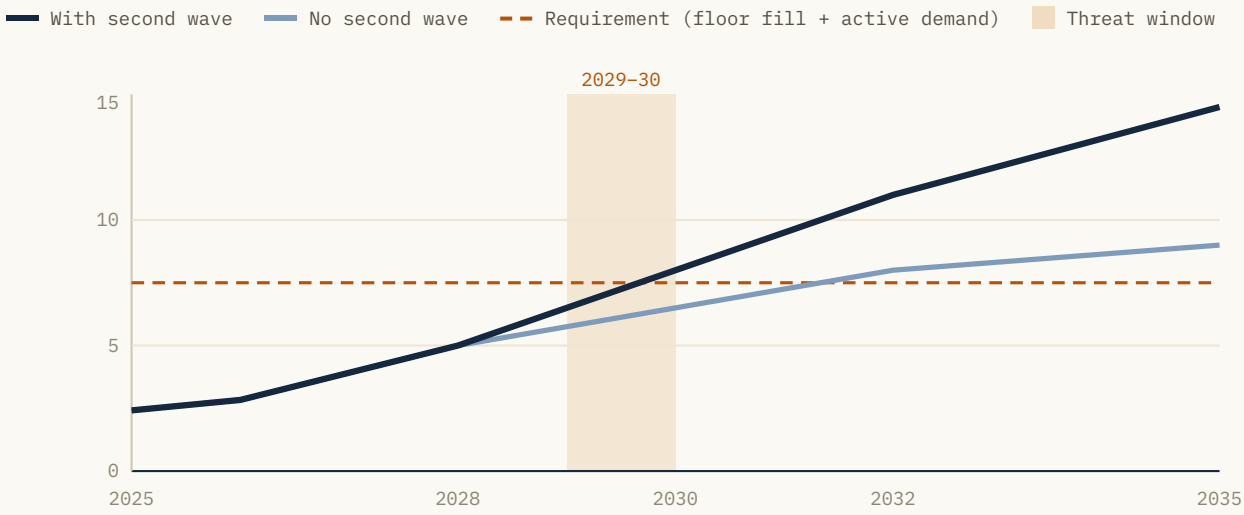
> ANALYTICAL DISCIPLINE
>
> The Outlook counts what is publicly visible and labels what is inferred. It is better to say ‘confirmed role, undisclosed tonnage’ than to fill gaps with convenient numbers. This restraint is what makes the bold conclusions defensible in front of the people who do know the classified numbers.

06 Europe's implied industrial timeline

The public programme is a first wave of resilience, not a complete strategic rebuild. The EU objective of ~2 million 155 mm rounds/yr — reported as achieved in early 2026[8] — is a major improvement on the early-war base and far below the output required to restore reserves quickly. European defence production overall has roughly tripled since 2022[55]. The central question is not gross production. It is net stockpile growth after active demand and leakage.

PHASE	CAPACITY	WHAT DRIVES THE UPLIFT	NET STOCKPILE EFFECT
2025–26: current ramp	~2.0–2.8m/yr	ASAP expansions, Unterlüss ramp, Glascoed filling uplift, higher utilisation	Limited: most output supports Ukraine, replenishment and backlog
2027–30: public capacity wave	~4.5–7.0m/yr	Unterlüss full rate, Bergerac, Victoria (RO), Nordic and Polish projects, UK factory pipeline	Moderate: net rebuild begins, constrained by Ukraine support and the TNT export window
2030–35: no second wave	~5.5–9.0m/yr	Announced projects mature; bottleneck shifts decisively to fill, propellant, LAP, storage, workforce	Meaningful but slow: reserves rebuild over decades
2030–35: with second wave	**~10–14.5m/yr**	Private/PPP fill, propellant, LAP, storage and QA added in parallel	**Strategic: baseline floor lands near the threat window; tiers become feasible**

FIGURE 3 **Illustrative European complete-round capacity pathway**



Complete rounds, m/yr. Only the second-wave trajectory clears the requirement line near the threat window; the announced-only path rebuilds reserves over decades.

6.1 Net rebuild: why gross capacity is misleading

If output goes to Ukraine, replaces donations, supports training, satisfies export contracts or is consumed in proof and qualification, it does not add to strategic reserves. The rebuild only accelerates when annual production materially exceeds annual active demand.

GROSS OUTPUT	ACTIVE DEMAND + LEAKAGE	NET GROWTH	30M FLOOR	TIER 2 (90M)
5.8m/yr	2.5m/yr	3.3m/yr	~9 yrs	~27 yrs
9.7m/yr	2.5m/yr	7.2m/yr	~4 yrs	~13 yrs
14.5m/yr	2.5m/yr	12.0m/yr	~2.5 yrs	~8 yrs
14.5m/yr	4.0m/yr	10.5m/yr	~3 yrs	~9 yrs

Figure 4. Net fill timelines for the baseline floor and Tier 2. Even the floor lands inside the threat window only with second-wave capacity.

> POLICY TENSION
>
> Allied assessments place possible Russian capability to threaten NATO at 2029–2030[47] [56]. A public programme that only matures into the mid-2030s is therefore strategically uncomfortable. That does not mean governments lack intent. It means the industrial timeline is slower than the threat timeline unless a second wave of capacity is financed and permitted in parallel.

6.2 The downside scenario: what a ceasefire does to this model

An intelligence assessment that models only rising demand is advocacy. We therefore state the bear case explicitly. Assume a durable cessation of hostilities in Ukraine in 2027. Direct Ukrainian consumption — the layer that absorbs most current output — falls steeply. Contract prices, which rose from ~€2,000–2,500 toward €3,600+ per round, would compress first in the most replicable lane: shell bodies and complete-round assembly. New-entrant body plants without offtake would be exposed immediately. Import competition from Korean, Indian and US producers would accelerate any glut.

Three demand layers nonetheless persist under contract and treaty. Replenishment of donated stocks is already contracted through multi-year frameworks. NATO capability targets — resourced by the 3.5% core-defence commitment with a 2029 review — are alliance obligations, not sentiment[1] [2]. And the sovereign-reserve logic this paper models becomes cheaper and politically easier to execute in a ceasefire, not harder, because output is freed from consumption. The layers most exposed to a ceasefire are precisely the lanes with the most announced capacity; the layers most protected are energetics and LAP, where the deficit is structural. A ceasefire therefore compresses margins for body producers while leaving the energetics case largely intact — which is why this Outlook weights the investment thesis toward fill, propellant and conversion rather than round counts.

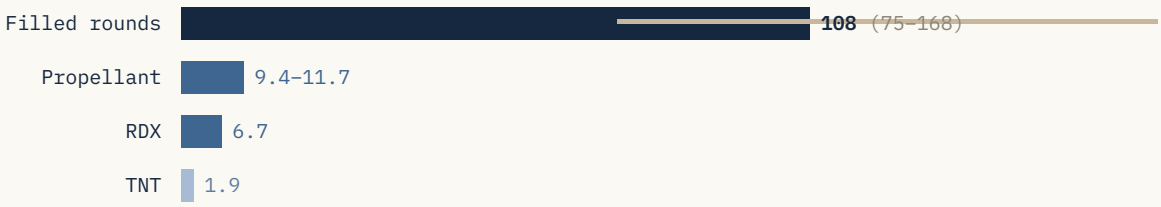
> WHAT WOULD BREAK THE THESIS ENTIRELY
>
> A simultaneous ceasefire, a NATO–Russia détente that removes the capability targets, and European governments choosing minimal days-of-supply stockpiles. We judge this combination highly unlikely within the assessment window, but indicator 14 in Section 11 tracks it.

07 Where the money actually is

The commercial value of a filled round understates the infrastructure opportunity behind it. A complete round embeds several constrained markets: body manufacture, fill, charges, LAP, QA, proof, packaging, storage and secure logistics. The value pools below are built from observed contract prices where they exist, and labelled planning assumptions where they do not. Observed anchors: Rheinmetall's large 2024 contract averaged ~€3,600 per round[49]; Ukrainian producers quote €2,500–5,500[50]; and the Nitro-Chem–US contract implies ~$17/kg for TNT[14].

MARKET LAYER	VOLUME	PRICE BASIS	VALUE POOL
Complete filled rounds (ex-fuze)	30m rounds	€3,600/rd central; range €2,500–5,600	**~€108bn**
Propellant	255–315 kt	€37/kg planning (low confidence)	**~€9.4–11.7bn**
RDX	180 kt	€37/kg planning (low confidence)	**~€6.7bn**
TNT	120 kt	~€16/kg implied by Nitro-Chem–US contract	**~€1.9bn**
LAP / QA / storage	30m rounds	Service and infrastructure value; no public benchmark	Multi-bn capex
Insurance tiers	55/90/140m	All pools scale ~linearly with reserve size	**×1.8 / ×3.0 / ×4.7**

FIGURE 5 **Baseline-floor value pools (€bn, cumulative programme value)**



The scarcest material is not the most valuable pool. TNT is cheap per kg yet strategically decisive; the filled-round pool dwarfs the energetics pools it depends on. Whisker on filled rounds shows the €2,500–5,600/rd price range.

Two corrections against the previous version of this Outlook are worth making explicit. First, the earlier $7/kg TNT planning price is contradicted by the one observable transaction — the US contract implies roughly $17/kg — so the TNT pool is larger than previously modelled. Second, the earlier inert-body value of $1,200 per body is no longer presented as an addable pool alongside complete-round value; body economics are instead analysed as a trade corridor in Section 7.1. Value pools are cumulative programme values across the rebuild period, not annual markets, and should be read as sizing the opportunity space rather than any single company's revenue.

The counterintuitive result stands: the most strategically scarce asset is not the most expensive material. TNT is cheap per kilogram and strategically decisive, because Europe has one dominant producing node and part of its output is committed outside Europe. LAP is less chemically complex than RDX synthesis yet monetises earliest, because it converts fragmented inputs into certified output.

7.1 The inert-body trade: corridor economics

A live trade corridor already exists between low-cost body producers and European filling capacity, and it validates the LAP-first logic of this paper. India's state producers have exported 155 mm projectiles and empty casings to Europe at scale: Yantra India shipped $35m of empty L15A1 casings to a single customer between February 2022 and July 2024[57]; Ordnance Factory Ambajhari delivered 100,000 M107 shells to a European buyer[58]; and Italy's MES operates precisely this model — buying empty Indian shells and filling them in Europe[59].

7.2 The freight staircase: why inert bodies pay a war-materiel premium

Freight for this cargo does not follow a smooth volume curve, and the reason is regulatory-commercial rather than physical. A truly inert body — no propelling charge, primer or energetics — is not IMDG Class 1 dangerous goods (UN 0012 applies to rounds with a propelling charge)[75]. But the freight market does not price by the letter of the IMDG code: mainline carriers apply military-cargo acceptance policies to anything recognisably a munitions component — Maersk formally tightened screening of all 'military-related cargo' in March 2025[66] — which pushes this cargo off mainline tonnage and onto a small pool of multipurpose and parcel carriers. Fewer willing carriers, specialised stowage and war-risk-adjacent insurance produce voyage-priced quotes.

LOT SIZE (40FT)	~BODIES	FREIGHT/BODY	BASIS
≤20 (pilot lots)	~10,000	~$145	Quoted: ~$1.45m per voyage
~50 (full parcel)	~25,000	~$58	Same voyage quote at full utilisation
51–99 (unquoted)	25–50k	~$58–90	Second voyage required; planning estimate
≥100/month (contracted)	≥50k/mo	Sub-$50 unproven	Gated on carrier contracting AND supply beyond ~45k bodies/mo; adds hub storage + multi-drop (~$10–25/body)

Two planning consequences follow. First, the corridor's competitive moat is partly logistical: an operator who can aggregate demand to fill 50-container parcels earns a ~$85–90/body freight advantage over pilot-lot competitors — larger than most machining cost differences between forges. Second, beyond current accessible supply (~45,000 bodies/month), flows route through a European storage hub and onward multi-drop distribution, so the true at-scale landed cost floor sits near $60–75/body of logistics, not the sub-$50 a naive curve would suggest.

WHY THE CORRIDOR MATTERS STRATEGICALLY — AND ITS LIMITS

The corridor is the fastest cash-generative entry into the ammunition system: it requires no synthesis plant, monetises the body/fill capacity gap immediately, and builds exactly the QA, certification and buyer relationships an LAP operator needs later. Its limits are equally clear: EU-origin and security-of-supply rules can exclude third-country bodies from sovereign war-reserve contracts; Indian export licensing is a policy variable; and the margin compresses as European body capacity matures. It is a bridge business that funds and de-risks the durable one: fill, LAP and energetics.

7.3 Plant economics and capex

The ranges below are planning bands, not EPC quotes. Environmental scope, utilities, safety distances, land preparation, automation, acid recovery, magazines and host-country permitting move outcomes materially. Reference points from the public record: Rheinmetall's integrated Unterlüss round plant cost ~€500m; its Victoria propellant JV exceeds €500m; SWEBAL's 4,500 t/yr TNT plant is financed with ~€30m of equity plus project debt; BAE's ~£150m munitions investment since 2022 delivered a sixteen-fold filling uplift; the US Repkon TNT plant is ~$404m.

PLANT TYPE	TYPICAL SCALE	INDICATIVE CAPEX	BUILD	READING
LAP / filling line	0.25–1.0m rounds/yr	$50–150m	18–36mo	Fastest route to finished-round value
TNT plant	4,000–5,000 t/yr	$90–200m	30–48mo	Narrow European base; high leverage
RDX plant	3,000–5,000 t/yr	$150–350m	36–60mo	Directly addresses modern HE fill
HMX module	500–1,500 t/yr	$75–200m	36–60mo	Premium missile/PBX expansion
NC / propellant campus	1,000–5,000 t/yr class	$250–600m+	36–60mo	Strategically vital; best with sovereign offtake
Integrated campus	Propellant + HE + LAP	**$800m–1.3bn+**	48–72mo	Highest value, highest execution risk; phase it

Figure 6. Indicative capex ranges by plant type. Planning bands anchored to disclosed project costs where available.

08 The second wave: barriers and enablers

The question for private and public–private capital is not which asset is most strategic, but which asset converts capital into certified output fastest while preserving the option to integrate upstream. On that test the first investable wave favours LAP, QA, storage, TNT and RDX; propellant remains critical but is better suited to sovereign-backed structures unless site, technology and buyers are already aligned.

#	ASSET CLASS	WHY THIS POSITION	COMMERCIAL LOGIC
1	**LAP / filling / QA / storage**	Fastest conversion of components into certified output; regulated but less complex than synthesis	Creates finished-round value and practical capacity buyers need now
2	**TNT**	Narrow base, export-leakage window 2027–29, low capex relative to leverage	Supports artillery, bombs and other munitions; SWEBAL proves new entry is viable
3	**RDX**	Modern HE fill constraint; direct leverage on 155 mm and premium compositions	More complex than TNT but strategically decisive; phase with offtake
4	**Propellant / modular charges**	Massive bottleneck but capital-intensive and qualification-heavy	PPP / sovereign offtake structures; feedstock resilience earns premium
5	**HMX / NTO / IM formulations**	Rising with the IM transition; premium markets	Missiles, advanced warheads, insensitive munitions

8.1 The honest obstacles

Three barriers gate the second wave, and any credible plan must name them. First, **qualification:** ammunition and energetics must be certified into specific national ammunition families, a multi-year process requiring a sponsoring customer — which is why anchor offtake or a prime partnership is not optional. Second, **feedstock circularity:** an LAP-first strategy that assumes imported fill must identify where that fill comes from during the exact window in which fill is scarce; realistic first-wave sources are allied non-European producers (US, Korea, India, Australia) bridging until European synthesis matures. Third, **sovereignty politics:** governments prefer national champions and government-owned capacity for war-reserve assets; the private-capital offer must therefore be framed as complementary compliant capacity that reduces pressure on public budgets. The UK's 'always on' munitions pipeline and 13-site factory programme[9] and the EU's SAFE joint-procurement instrument[4] are exactly the demand-side structures a second-wave investor should anchor to.

CAPACITY TYPE	BEST PUBLIC ROLE	BEST PRIVATE ROLE	FINANCING MODEL
Strategic sovereign plants	Anchor demand, grants, permits, security case	Delivery partner / minority capital	PPP / availability-style support
LAP / storage	Licensing and offtake	Build, operate, certify, aggregate inputs	Private capex + long-term contract
TNT / RDX	Permits, environmental approval, guaranteed demand	Build new allied capacity	Project finance / infrastructure equity
Propellant	State support, qualification, long offtake	Specialist operator / technology partner	Sovereign-backed project finance
QA / proof / testing	Standards and certification regime	Independent service capacity	Service contract / regulated utility model

09 Future proofing: the insensitive-munitions transition

Any facility financed in 2026 will still be operating in 2050. The question is therefore not only what Europe needs to fill shells with today, but what fills will be qualified tomorrow. The direction of travel is settled in the United States: IMX-101 — a melt-pour formulation of DNAN, nitroguanidine and NTO containing no TNT or RDX — has been the qualified TNT replacement in the 155 mm M795 since 2010, produced at scale at Holston under orders that reached $780m as early as 2013[53] [54] [60]. It was the first explosive fully IM-qualified under NATO STANAG guidance[53]. Europe's own IM adoption is slower and nationally fragmented, which is exactly what makes it a strategic design choice for new capacity rather than a settled requirement.

9.1 The strawman: 'build IM-native and skip the old chemistry'

The strongest version of the argument runs: TNT/Comp B is legacy chemistry with a shrinking qualification future; a new entrant should build IM-native fill and LAP capacity, differentiate on where the market is going, avoid competing with Nitro-Chem on incumbent chemistry, and let the stockpile logic do the rest — reserves stored for decades are precisely where IM's safety and dense-storage benefits compound. The cost objection is weak: IMX-101 runs ~$8/lb against ~$6/lb for TNT, and US programme data puts the fill-cost delta around $100–130 on an M107-class round.

9.2 The counter-case, taken seriously

Four objections must be answered before committing capital to IM-first. First, **qualification lag:** most European 155 mm ammunition families remain qualified around TNT and Comp B-class fills; an IM-native plant sells into a requirement European customers have not yet written, and requalification of fielded families is slow and nationally controlled. Second, **near-term demand is overwhelmingly for conventional fills** — Ukraine, replenishment and current-family production all specify existing compositions. Third, **feedstock:** the IM route does not escape the precursor problem, it relocates it — nitroguanidine carries the same China exposure[41], and Europe's visible NTO base is effectively Chemring Nobel plus one other producer[26] [27]. Fourth, **performance:** IMX-101 is a TNT-equivalent, not a Comp B-equivalent; RDX-rich and premium fills retain a lethality role.

9.3 Assessment: dual-capable is the future-proof position

The resolution is not a bet on either chemistry. DNAN-based IM fills are melt-pour compositions processed on melt-cast infrastructure that is deliberately similar to TNT-based production. A new fill/LAP facility can therefore be designed dual-capable at modest incremental cost: pouring TNT and Comp B-class fills for today's contracted demand, with lines, safety cases and QA regimes

engineered from day one for DNAN/NTO IM compositions as European qualification catches up with US practice. Paired with a position in NTO — the scarcest IM ingredient with the narrowest European base — this converts the IM transition from a threat into the plant's second demand wave.

> FUTURE-PROOFING JUDGEMENT
>
> We assess it is **likely** (**55–75%**) that new-build European 155 mm fill qualified after ~2030 will be predominantly IM-class, following US practice and NATO safety policy. We therefore recommend that any fill or LAP facility financed now be specified dual-capable (TNT/Comp B and DNAN/NTO melt-pour), and that NTO capacity be treated as a premium strategic wedge alongside RDX. What would change this judgement: European requalification programmes stalling beyond 2032, or a major customer explicitly recommitting to conventional fills for war-reserve stock. Indicator 17 (Section 11) tracks this.

10 Analysis of alternatives: what would change our judgements

Structured challenge is part of the method. Five alternative hypotheses were tested against the evidence; each is stated with the observation that would cause us to revise.

ALTERNATIVE HYPOTHESIS	OUR ASSESSMENT	WHAT WOULD CHANGE OUR MIND
Drones and precision strike make mass artillery obsolete	**Rejected on current evidence:** both combatants in Ukraine pair rising drone use with sustained multi-million-round artillery consumption; drones improve targeting, they do not deliver sustained suppressive mass	European armies formally reducing artillery force structure or NATO de-emphasising 155 mm stockpiles
A ceasefire collapses demand and strands new capacity	**Partially accepted and modelled (6.2):** body/round margins compress; energetics and LAP deficits persist under treaty-anchored demand	Ceasefire plus removal of NATO capability targets plus explicit minimal-stockpile policy decisions
Governments will choose modest days-of-supply stockpiles	**Adopted as the paper's baseline:** the 30m floor is precisely that assumption, and the bottleneck holds at it (Fig. 2). Insurance tiers priced separately as optional upside	Announced energetics capacity expanding several-fold beyond current public plans, closing even the floor gap
Technology bypasses the bottleneck	**Watching:** the most credible disruptor on record — BAE's continuous-flow route removing NC/NG dependence[39] [40] — but unproven at scale and specific to propellant, not TNT/RDX fill	Scale demonstration of continuous-flow energetics production with a qualified ballistic product
Import arbitrage closes the gap without European build-out	**Partially credible** for bridging feedstock and rounds; incompatible with stated EU/UK sovereignty policy as the end-state; and US capacity is being reserved for US rebuild	European procurement systematically waiving origin requirements for war-reserve stock

11 Indicators and warning: the next 24 months

This assessment is a dated snapshot. The indicators below are observable, public, and each is tied to a specific judgement it validates or degrades. VitalSpec maintains these as a standing watch-list; material changes will be reflected in Outlook updates.

#	INDICATOR	VALIDATES / DEGRADES
1	Nitro-Chem second TNT line: construction start and commissioning date	KJ3 — timing of TNT window closure
2	SWEBAL Nora: construction milestones toward 2028 full output	KJ3, KJ6 — private new-entry viability
3	Repkon Kentucky TNT plant progress toward Feb 2029 completion	KJ3 — US demand receding from European TNT
4	Nitro-Chem–PROZAP RDX/HMX facility: investment decision and construction	KJ4 — RDX gap closure rate
5	Rheinmetall 3,000 t/yr RDX: confirmation of actual output from 2026	KJ4 — announced vs delivered capacity
6	Chemring Nobel new-facility decision following feasibility study	KJ4 — advanced-HE and NTO capacity
7	Rheinmetall Victoria (RO): construction progress toward 2028 charges output	Propellant lane timing
8	Eurenco Bergerac: full-rate operation of new powder lines	Propellant lane timing
9	UK energetics factories: first groundbreaking among 13 candidate sites	KJ1, KJ6 — UK demand-side structures
10	SAFE tranche allocations flowing to ammunition/energetics projects	KJ1 — EU demand durability
11	NATO 2029 review: stockpile targets maintained or raised	KJ7 — treaty-anchored demand
12	Chinese export-control actions on nitrocellulose, linters or nitroguanidine	KJ5 — precursor risk crystallising
13	155 mm contract prices: sustained above ~€3,000 (scarcity) or falling toward ~€2,000 (glut)	Section 7 value pools
14	Ukraine ceasefire developments and whether replenishment orders continue afterwards	KJ7 — downside scenario trigger
15	Fuze framework expansions beyond current Junghans-class contracts	Adjacent-constraint pressure on complete rounds
16	Scale demonstration of NC/NG-free continuous-flow propellant	Section 10 — technology bypass hypothesis
17	European IM requalification programmes and new NTO/DNAN capacity announcements	Section 9 — future-proofing judgement

FINAL THESIS

Europe must rebuild the ability to manufacture high-explosive fill, propelling charges and certified ammunition at scale. Public programmes are necessary but, on the evidence assembled here, unlikely to close the rebuild gap within the threat window their own governments have identified. Private and public–private capital can accelerate compliant capacity where governments have created demand but cannot build or finance every required asset themselves.

The winners will be system integrators who convert capital into certified production, certified production into bankable offtake, and bankable offtake into sovereign supply assurance.

SUPPORTING MATERIAL

Annexes

A Facility map · B Modelling assumptions · C Assumptions check · D Insurance tiers · E Source register

Annex A — Facility and capacity map

A modelling map, not a census. It separates visible public roles from inferred or undisclosed capacity, to prevent double-counting and to identify where published capacity should be converted into complete-round equivalents.

LANE	COMPANY	SITE	PUBLIC CAPACITY SIGNAL	MODEL TREATMENT
TNT	Nitro-Chem / PGZ	Bydgoszcz, PL	~10,000 t/yr, doubling to ~20,000 t/yr; 18,000 t US contract 2027–29	Major TNT node; export-leakage sensitivity
TNT	SWEBAL	Nora, SE	4,500 t/yr; financed; construction 2026; full output 2028	Planned relief from 2028
TNT US	Repkon USA / US Army	Graham, KY	~$404m; first US domestic TNT since 1980s; completion Feb 2029	Not European; closes US demand on Europe
RDX	Rheinmetall	Germany (group)	3,000 t/yr from 2026; 1.5m propellant modules	~500k shell-equivalents at 6 kg
HE	Chemring Nobel	Sætre, NO	RDX/HMX/NTO; doubling with £32m EU/NO co-funding; new facility studied; Northrop LTA	Confirmed role, undisclosed tonnage
RDX+	Nitro-Chem + PROZAP	Poland	Design agreement Nov 2025 for new RDX and potentially HMX facility	Planned, not current capacity
Prop	Eurenco	Bergerac, FR	~$540m; NC restarted; first new line Jan 2025; 1,200 t at full rate 2027	Propellant chain, not fill
Prop	Rheinmetall + Pirochim	Victoria, RO	>€500m JV; ~300k modular charges/yr from 2028; 20,000 t/yr powder by 2030	Largest single propellant addition
NC	CSG / MSM Walsrode	Walsrode, DE	Nitrocellulose industrial base	Feedstock, not qualified propellant
LAP	BAE Systems	Glascoed, UK	16× 155 mm filling uplift from summer 2025; ~£150m since 2022	LAP/throughput; no confirmed UK synthesis
Rounds	Rheinmetall	Unterlüss, DE	€500m plant, 15-month build, 350k rounds/yr by 2027; ambition 1.1–1.5m	Integrated output; not all open-market
Bodies	CSG / ZVS	Snina, SK	360k bodies/yr by 2026; >€80m cumulative investment	Body lane only until fill/charges paired
Rounds	PGZ / Mesko / Dezamet	Kraśnik, PL	>2.4bn PLN programme; Mesko toward 150k rounds/yr by 2027	Body/round lane; energetics dependency
Rounds	KNDS France	FR / PL proposal	Proposal to meet Poland's 200k/yr goal	Projectile/LAP ecosystem
Fuzes	Junghans	Germany	10-yr frameworks incl. up to 420k MOFA fuzes	Initiation lane, tracked constraint

Annex B — Modelling assumptions and conversion factors

Every material assumption used in the model, with its value and rationale. Values are deliberately conservative planning inputs, not claims of precision.

INPUT	VALUE USED	REASON
Explosive fill per 155 mm HE projectile	10 kg	Rounded planning assumption for modern HE fill burden
RDX/TNT split	60/40	Central RDX-rich planning case; see IM sensitivity, 3.1
RDX per shell	6 kg	10 kg fill × 60%
TNT per shell	4 kg	10 kg fill × 40%
Central propellant per round	8.5 kg	Four-module planning case at ~2.1 kg/module
High-zone propellant per round	10.5 kg	Five-module sensitivity
4,500 t/yr TNT plant	~1.125m shells/yr	4 kg TNT per shell
3,000 t/yr RDX plant	~0.5m shells/yr	6 kg RDX per shell
4,500 t/yr propellant plant	~529k / ~429k shells/yr	8.5 kg central / 10.5 kg high-zone
LAP line planning capacity	200k–500k rounds/yr	Illustrative range to size sites
Active demand + leakage	2.5m/yr central; 4.0m/yr	Ukraine support, donation replacement, training, proof, exports
Baseline requirement (floor)	30m rounds	Triangulated from three independent methods (2.1–2.2)
Insurance tiers	55 / 90 / 140m	Duration-anchored (Annex D); scale ×1.8 / ×3.0 / ×4.7
Announced-capacity planning estimates (Figs. 1–2)	RDX 10 kt; TNT 24.5 kt; prop 30 kt by ~2030	Generous reading of announced projects; biases the test against the paper's own conclusion
Currency conversions	US$1.00 = €0.92	Fixed for internal consistency; value pools are order-of-magnitude tools

Annex C — Key assumptions check

Every material assumption, its basis, and the consequence of being wrong. This is the table a challenge function should attack first.

ASSUMPTION	BASIS	IF WRONG	CONFIDENCE
30m floor as modelling baseline	Triangulated from consumption, barrel park × DOS, adversary output (2.1)	A higher true floor strengthens every finding; a materially lower one is contradicted by all three methods	**Moderate**
Insurance-tier sizing (55/90/140m)	Duration-anchored derivations (Annex D)	Tiers are explicitly scenarios; no conclusion depends on them (Fig. 2)	Planning choice
10 kg fill, 60/40 RDX/TNT	Conventional composition planning case	IM transition shifts demand to NTO/DNAN/NQ — different molecules, same constraint (3.1)	**Moderate**
8.5/10.5 kg propellant per round	Modular charge weights, four/five module cases	Round-equivalents per plant shift ~20%; both cases carried	**Moderate**
Nitro-Chem ~10–12 kt/yr TNT today	Public reporting	European TNT margin thinner or thicker by ~±20%	**Moderate**
18,000 t US export = leakage 2027–29	Contract reporting	If partly produced on new line, leakage effect smaller	**High** (contract)
Rheinmetall 3,000 t/yr RDX from 2026	Company/EU announcement	Announced ≠ delivered; indicator 5 tracks	**High** (announced)
Chemring Nobel tonnage undisclosed	No public figure	If large, RDX gap smaller than modelled; deliberately not guessed	—
2.5m/yr active demand during rebuild	Ukraine support + replenishment + training/proof/exports	Net fill years move materially (6.1 shows 4.0m case)	**Low**
No deduction for residual national stocks	Stocks unknown; four years of depletion	Equivalent to reading one rung lower on the ladder	Planning choice
BND/Bundeswehr threat window 2029–30	Public statements	Later window relaxes urgency, not direction	Reported, not our judgement

Annex D — Strategic insurance tiers: derivation and conversions

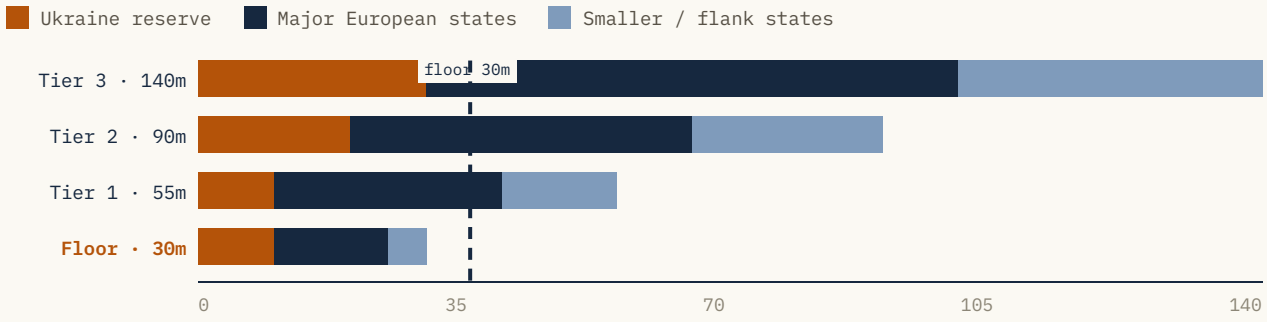
The baseline floor (2.2) is what a sceptical planner concedes. The tiers below price what serious insurance would cost. Each is anchored to a duration with a defensible planning meaning, not to an arbitrary reserve-years multiplier.

Tier 1 — mobilisation bridge (~55m rounds, ×1.8). The floor plus three years of alliance-wide war consumption at a ~4.5m rounds/year planning rate — triangulated between Ukraine's stated requirements (~200,000/month) and Russia's 2025 production-plus-imports usage — with a wastage, attrition and training margin. Three years is chosen because it is Europe's demonstrated mobilisation time: the 2022–25 ramp roughly tripled European output. Tier 1 answers: could Europe fight while its industry mobilises, without rationing fire?

Tier 2 — sustained defence (~90m rounds, ×3.0). The floor plus a decade of adversary-matched supply. Estonia's assessment puts Russian howitzer-shell production at ~3.4m/year with substantial DPRK and Iranian imports on top — call it ~4.5m/year of usable supply, or ~45m over a decade — plus a ~20% survivability margin reflecting that stored ammunition can be struck and dispersed holdings duplicate stock. Tier 2 answers: at what level does European depth stop being the variable Russia can plan around?

Tier 3 — continental depth (~140m rounds, ×4.7). Tier 2 extended across wider NATO-Europe (including a Türkiye sensitivity and doubling of flank-state holdings), plus insurance against the early loss of production capacity — assuming first-wave strikes halve European output for the first two years of a peer war. Tier 3 answers: what would it take for the continent as a whole, not just its front-line states, to hold settled strategic depth?

FIGURE 7 **Insurance tiers stacked across buyer groups (m rounds)**



Tiers are stacked across buyer groups, not single-buyer forecasts. The dashed line marks the baseline floor.

MATERIAL CONVERSIONS

REQUIREMENT	FLOOR (30M)	TIER 1 (55M)	TIER 2 (90M)	TIER 3 (140M)
Explosive fill (10 kg/rd)	300 kt	550 kt	900 kt	1,400 kt
RDX (6 kg/rd)	180 kt	330 kt	540 kt	840 kt
TNT (4 kg/rd)	120 kt	220 kt	360 kt	560 kt
Propellant central (8.5 kg/rd)	255 kt	467.5 kt	765 kt	1,190 kt
Propellant high-zone (10.5 kg/rd)	315 kt	577.5 kt	945 kt	1,470 kt
LAP throughput (complete rounds)	30m	55m	90m	140m
Years of RDX output at 10 kt/yr	**18**	**33**	**54**	**84**

HONESTY NOTE

No European government has announced procurement at any tier, and absent a direct and proximate threat none is likely to this decade. The tiers exist so that when threat perception moves — as it did after 2022 — the cost of moving up the ladder is already priced, and so that readers can see the paper's conclusions do not depend on them: every bottleneck finding triggers at the floor.

Annex E — Source register

All sources are public. Inline citation numbers throughout this paper are hyperlinked directly to the source; the register below lists every reference in full. Evidence hierarchy: official government/NATO/EU statements; company announcements; reputable press reporting of disclosed contracts or permits; analytical inference, labelled as such in the text.

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FINAL NOTE

This Outlook deliberately avoids precision where public data is not precise. It does not claim classified stockpiles, undisclosed plant tonnage or guaranteed procurement decisions. Its value is in the architecture: converting public evidence into a coherent, challengeable model of strategic demand, industrial bottlenecks and the investment required to compress rebuild timelines — together with the indicators that will show, in public, whether it is right.

VITALSPEC DEFENCE INDUSTRIAL OUTLOOK 2026 END OF ASSESSMENT OUTLOOK PAPER 01 · V4.4