USER MANUAL

ESTINEER ATMOSPHERIC STORAGE TANKS

Shop-built atmospheric tanks up to 100 m³: design checks, material take-off, man-hours, price, drawings and reports

www.estineer.com / support@estineer.com
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Software output only: must be checked and approved by a qualified engineer. Not engineering advice and not an estimate or quotation.

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CHAPTER 1

INTRODUCTION

1.1 WHAT THE TOOL IS

The Estineer Atmospheric Storage Tanks tool designs and prices a shop-built atmospheric storage tank from a short datasheet. You describe the tank: what it stores, how big it is, what it is made of, where the nozzles go. The tool then works out the plate thicknesses, checks them against the chosen design standard, lays out the plates and welds, lists every material item, builds the fabrication activities with man-hours, and prices the job.

The same model drives everything you see: the 3D view, the general arrangement and shop drawings, the calculation report, the estimate report, and the Excel and Word files. Change a field and all of them change together, so the drawings can never disagree with the price.

1.2 WHAT GOES IN AND WHAT COMES OUT

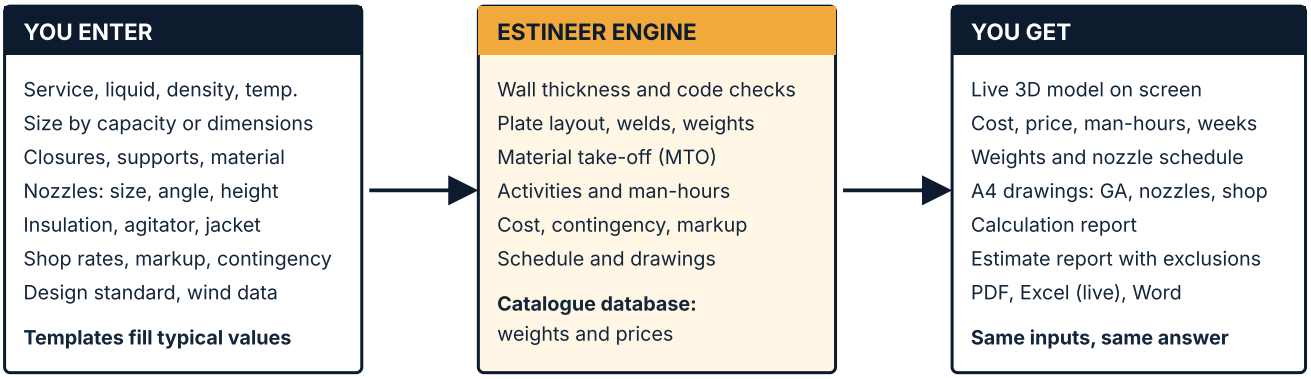


Figure 1.1 What goes in, what happens, what comes out. There is no AI in the number path: every figure comes from the engine and the catalogue database.

The tool runs entirely on engine rules and a catalogue database of weights and prices. It uses no artificial intelligence to produce a number. If you enter the same inputs twice you get the same result, and every report carries a check code that proves which inputs, engine version and database produced it (Chapter 5).

Who it is for

Fabricators who need a fast, traceable cost and a drawing pack for a small tank enquiry; engineers and estimators who need a first-principles check of a quote; and project teams that want a budget price with an honest list of what is not included.

1.3 WHAT THE TOOL COVERS

Item	Covered
Tank type	Shop-built, atmospheric (no internal pressure other than liquid head), full of liquid at design
Size	Capacity 0.5 to 100 m^3; inside diameter 0.6 to 4.0 m (road transport limit); shell height 0.5 to 12 m
Layouts	Vertical on legs, skirt or slab; horizontal on saddles (Figure 1.2)
Two modes	**Designed by this tool:** the tool sizes the tank, runs the design checks and issues the calculation book. **Designed by the client:** you enter the client's thicknesses and details; the tool gives the fabrication estimate and drawings only, and lists any point to raise with the client
Services	Dairy (hygienic, 316L default), sulphuric acid 93 to 98 % (carbon steel), and general liquids; each starts from a template you can change
Materials	Carbon steel, stainless 304, stainless 316L
Design standard	API 650 (Annex J, shop-built tanks) or AS 1692 with AS/NZS 1170.2 wind (Australia)
Fittings	Any number of nozzles and manways, each on its own card: size, type, angle, height and projection; sanitary, flanged or coupling; a separate nozzle orientation drawing
Options	Insulation and cladding, agitator (top or side entry), cooling jacket (dimple or half-pipe), one-way sloped bottom, leg rings
Currency	AUD by default, any currency by exchange rate; prices exclude GST and tax



A Vertical, legs
ellipsoidal top, cone bottom

B Vertical, skirt
dished top and bottom

C Vertical, on slab
cone roof, flat bottom, painted CS

D Horizontal
dished ends, saddles

Figure 1.2 The four layouts the tool handles, rendered by the tool from its own 3D model. Closures can be mixed within each layout; all are shown in Chapter 3.

Usual range and hard limit. Each numeric field has two bands. Outside the **hard limit** the tool refuses to run and says why (red). Inside the hard limit but outside the **usual range** it runs and shows a yellow warning asking you to confirm the value. Chapter 3 lists both bands for every field.

1.4 WHAT THE TOOL DOES NOT COVER

- Pressure vessels and tanks with internal pressure or vacuum design.
- Tanks above 100 m^3 or 4 m diameter, and field-erected tanks.
- Seismic design. It needs site data; the report states this clearly (API 650 Annex E or AS 1170.4 as applicable).
- Foundations, civil works and anchor bolts setting; transport, unloading and erection.
- Vendor items: the agitator, instruments and similar equipment are listed but priced at zero, in a red box saying you must obtain quotations.
- Cooling duty, chiller or refrigeration plant, and jacket piping.
- Escalation, financing, overtime and design changes after drawing approval.

Responsibility. Every output is for review. A qualified engineer must check and approve it before fabrication. The tool gives engineering data and a cost model, not engineering advice and not a quotation. The full statement is printed once, on the cover of the report and on the first page of the Excel and Word files; every drawing is marked FOR REVIEW.

1.5 WHERE THE NUMBERS COME FROM

Quantity	Source
Plates, formed heads, legs	Computed from geometry and plate stock sizes (no catalogue exists for these); weight from density
Pipe, flanges, fittings, sanitary sets	Catalogue database weights and prices; weights are never computed from geometry
Plate prices	Database (per kg by material, converted to your currency); you can override rolling with a subcontract rate
Man-hours	Built activity by activity from weld lengths, plate counts, fit-up, test and inspection rules
Labour cost	Hours multiplied by your three all-in rates: shop, engineering and NDT
Allowable stresses, minimum thicknesses	Declared assumptions inside the engine, listed in the calculation report

Where a figure is an assumption rather than data, the report says so. Prices are budget level, in 2026 dollars, and stay valid only until a vendor or workshop quote replaces them.

1.6 THE SCREEN AT A GLANCE

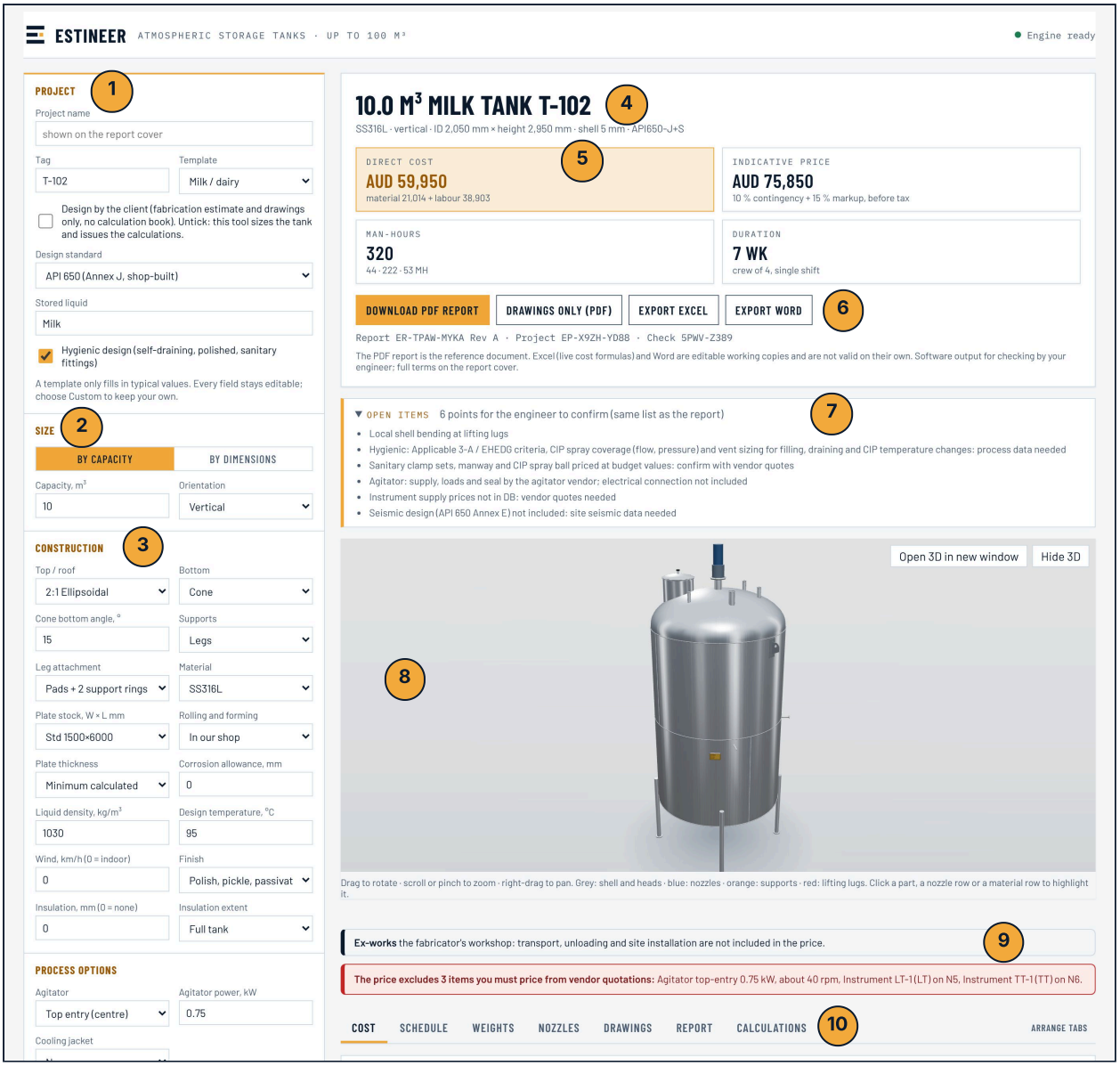


Figure 1.3 The tool page with a milk tank loaded. The numbers match the key below.

1. **Project:** name, tag, template, design by the client or by this tool, standard, liquid, hygienic.
2. **Size:** by capacity or by dimensions; vertical or horizontal.
3. **Construction:** closures, supports, material, plates, density, temperature, wind, finish, insulation. Process options, nozzle cards and workshop rates follow below.
4. **Title:** capacity, service, tag and the main dimensions.
5. **Result cards:** direct cost, indicative price, man-hours, duration.
6. **Downloads:** PDF report, drawings, Excel and Word; the ids shown on screen are registered and become verifiable only at purchase.
7. **Open items and checks:** points the engineer must confirm, in amber; the same list and count as in the report.
8. **3D model:** drag to rotate, scroll to zoom, right-drag to pan; click a part to highlight it; open it in its own window.
9. **Scope notices:** ex-works basis and the red list of items you must price from vendor quotations.
10. **Tabs:** Cost, Schedule, Weights, Nozzles, Drawings, Report, Calculations; their order can be changed.

1.7 PREVIEW AND THE PURCHASED REPORT

The tool is free to use on screen. You can enter any tank, watch the 3D model, read the cost and weights, and see the drawings.

	Free preview on screen	Purchased report
Cost, price, man-hours, weights	Full	Full
Drawings	Low resolution, marked PREVIEW, NOT VALID	Clean A4 vector sheets
Report and calculations	Check summary in full; report and calculation sheet: first page only, the rest is blurred	Complete PDF
Excel and Word	Not available	Live-formula workbook and editable Word file
Ids and verification	Not issued; ids are registered and verifiable only after purchase	Report id, project id, revision code and check code

To buy, press a download button, sign in with a six-digit code sent to your email, and pay by card. Files are produced on the server only after payment is confirmed, you receive a tax invoice, and you can download again for 12 months. One revision within 24 hours of purchase is free. Prices and offers are shown on the site at the time of purchase.

> The PDF report is the reference document. The Excel and Word files are editable working copies and have no standing on their own.

1.8 CONVENTIONS USED IN THIS MANUAL

- **Units.** Metric throughout: mm for lengths of parts, m for tank dimensions, kg, MPa, m^3, °C, kW. The unit is always in the field label.
- **Money.** AUD, excluding GST, at the exchange rate in the form (default 1 AUD = 0.68 USD).
- **Alerts.** Yellow means confirm; red means the run is stopped or a check fails.
- **Field names.** Written exactly as on screen, for example *Corrosion allowance, mm*.
- **Figures.** Overview pictures are renders from the tool's 3D model. Technical figures are black-and-white drawings with English labels, third-angle projection.
- **Standards.** Referred to by name only. The manual does not reproduce standard text.

1.9 GETTING HELP

Email **support@estineer.com** with your report id. The check code lets us reproduce your exact result.

CHAPTER 2

QUICK START

This chapter takes you from an empty page to a priced tank with drawings in five steps. The example is the 10 m³ milk tank that loads when you open the tool. Every field you skip keeps a sensible default, so a first result appears after step 2.

1 Describe the project

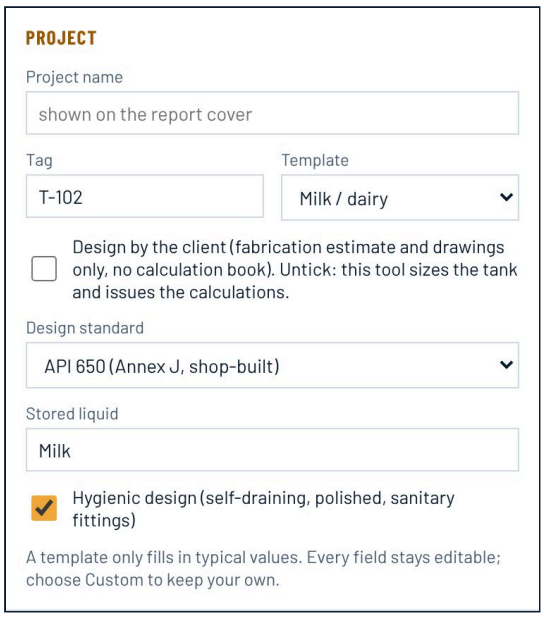


Figure 2.1 The Project section.

Type a **project name**. It prints on the report cover only.

Give the tank a **tag**, for example T-102. It names every drawing and file.

Pick a **template**: Milk / dairy, Sulphuric acid 93–98 %, General / water, or Custom. A template fills typical values for material, closures, supports, nozzles and finish. Every field stays editable afterwards.

Leave **Design by the client** unticked if this tool should size the tank and issue the calculations. Tick it when the client has already designed the tank and you only need the fabrication estimate and drawings (Chapter 3).

Choose the **design standard** and check the **stored liquid** and **hygienic** box.

2 Set the size



Figure 2.2 The Size section.

Choose **By capacity** and type the volume in m³. The tool picks a diameter and height that suit road transport and a sensible height-to-diameter ratio.

Or choose **By dimensions** and type the inside diameter and shell height (or length, for horizontal tanks) in mm.

Pick **vertical** or **horizontal**. The result updates as soon as you leave a field.

3 Check the construction

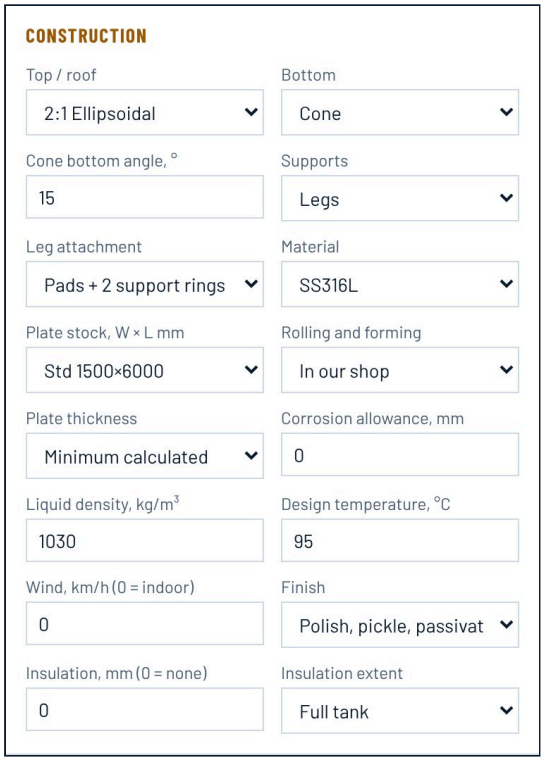


Figure 2.3 The Construction section (top part).

Confirm the **top** and **bottom** closures, the **supports** and the **material**. A combination the tool does not design (for example a flat bottom on a skirt) gives a plain message instead of a result (Section 3.4).

Set the **liquid density**, **design temperature**, **corrosion allowance** and **wind** (0 for a tank installed indoors).

Leave **Plate thickness** on *Minimum calculated* unless the client has specified thicknesses.

Pick the **finish** and, if needed, the **insulation** thickness. Changing the material sets the finish for you (stainless: polish and passivate, CA 0; carbon steel: blast and paint); you can still change both.

4 Add nozzles, options and rates

Open the **Nozzles** tab to check the openings the template added. Each nozzle is a card: click it to change the mark, service, size, location, type, flange class, angle, position and projection, or press **Add nozzle**. Grey numbers are the engine's automatic values; type a number to fix your own.



Figure 2.4 Nozzle cards in the Nozzles tab.

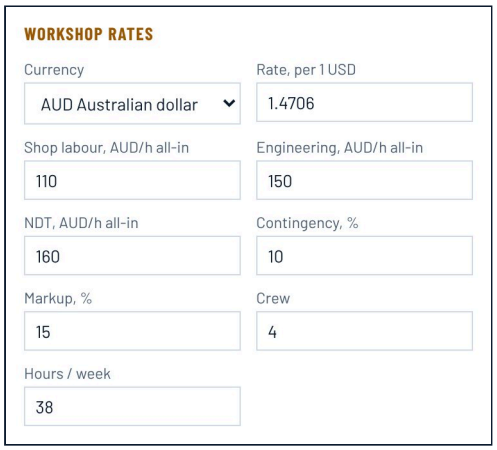


Figure 2.5 Workshop rates.

Under **Process options** choose an agitator and a cooling jacket if the service needs them.

Under **Workshop rates** set the currency and its rate to the US dollar, your three all-in hourly rates (shop, engineering, NDT), contingency, markup, crew size and hours per week. These change cost and duration, never the design.

5

Read the result and download

The result panel shows the title line, four result cards and the download buttons. Read the amber **open items** and **checks** first: they are the points an engineer must confirm. Then look through the tabs (Chapter 5).

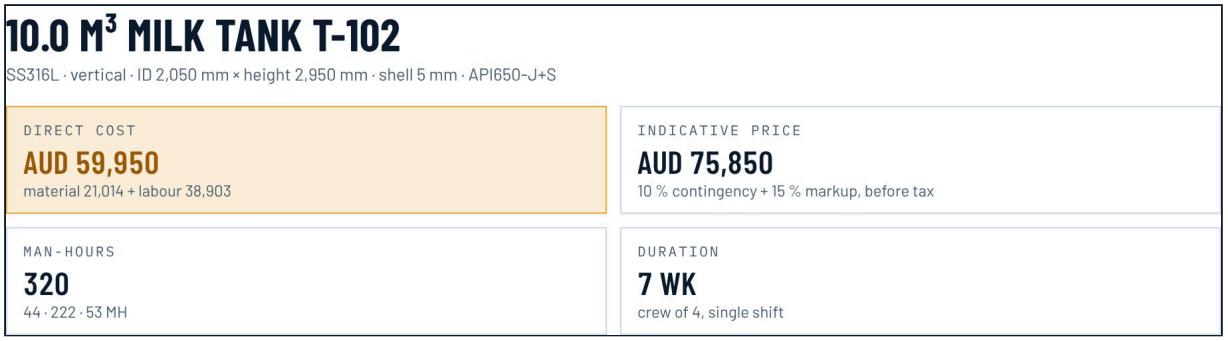


Figure 2.6 Title line and the four result cards.

Download PDF report gives the complete report: cover, estimate, calculations and all drawings in one file. **Drawings only**, **Export Excel** and **Export Word** give the other files. On the website, a download asks you to sign in with an emailed code and pay for the report; the files are then made on the server.

2.1 CHECKLIST BEFORE YOU SEND A PRICE

- Is every amber open item answered, or listed as an assumption in your offer?
- Is the red box of excluded vendor items priced from real quotations?
- Do the nozzle sizes, angles and elevations match the client's datasheet?
- Are the workshop rates, markup and contingency your own?
- Has a qualified engineer reviewed the calculations and drawings?

> The same inputs always give the same result. Save the PDF report with your offer: its check code proves which inputs, engine version and database produced it.

CHAPTER 3

INPUTS, FIELD BY FIELD

Fields are listed in screen order. **Limits** give the hard limit (outside it the tool stops and says why, in red) and, in brackets, the usual range (outside it the tool runs but asks you to confirm, in yellow). A dash means the field is a choice, not a number.

3.1 PROJECT

Field	What it means and what it changes	Default	Limits
Project name	Printed on the report cover. No effect on the design or price.	empty	–
Tag	Equipment number. Names the drawings (for example ESTN-T-102-01) and the files.	T-102	–
Template	Milk / dairy, Sulphuric acid 93–98 %, General / water, or Custom. Fills typical material, closures, supports, nozzles, density, temperature and finish. Custom keeps what you typed.	Milk / dairy	–
Design by the client	Ticked: you enter the client's thicknesses and sizes; the tool keeps them, prices the fabrication and draws the tank, and lists failed background checks as points to raise with the client. No calculation book is issued. Unticked: the tool sizes the tank and issues the calculations.	unticked	–
Design standard	API 650 (Annex J, shop-built tanks, selected methods) or AS 1692 with AS/NZS 1170.2 wind. Sets minimum thicknesses, joint efficiency, wind method and the code references in the report.	API 650	–
Stored liquid	Name of the product, printed on drawings and reports.	by template	–
Hygienic design	Self-draining bottom, polished product surfaces, sanitary clamp fittings, continuous welds ground flush inside. Adds polishing and passivation work.	on for dairy	–

3.2 SIZE

Field	What it means and what it changes	Default	Limits
By capacity / By dimensions	Capacity: the tool chooses the diameter and height. Dimensions: you give them.	By capacity	–
Capacity, m^3	Geometric volume to the top of the shell.	10	0.5 to 100
Orientation	Vertical or horizontal (Figure 1.2).	Vertical	–
Inside diameter, mm	Shown with By dimensions. Road transport limits it to 4 m.	2000	600 to 4000
Shell height / length, mm	Vertical: shell height. Horizontal: length between tangent lines.	by capacity	500 to 12000; H/D 0.5 to 4, L/D 1 to 6

3.3 CLOSURES

Field	What it means and what it changes	Default	Limits
Top / roof	Torispherical, 2:1 ellipsoidal, cone, dome, flat or open top (Figure 3.1). An open top moves roof nozzles to the upper shell and drops the vent and manway.	by template	–
Cone roof angle, °	Slope of a cone roof from horizontal. API 650 asks for 9.5 to 37°; outside it the check is NOT OK.	10	5 to 45
Bottom	Flat, flat sloped one way, torispherical, 2:1 ellipsoidal or cone (Figure 3.2). Formed and cone bottoms drain to a centre outlet.	by template	–
Bottom slope, °	For the sloped flat bottom: the plate is tilted one way, low side at 90°, to a side outlet.	2	1 to 10
Cone bottom angle, °	Slope of a cone bottom from horizontal. A steeper cone drains better and needs a thinner plate and a smaller junction ring.	15	5 to 60



Figure 3.1 Top closures, from left: torispherical, 2:1 ellipsoidal, cone, dome, flat, open top.



Figure 3.2 Bottoms on legs, from left: flat, flat sloped one way, torispherical, 2:1 ellipsoidal, cone.

3.4 SUPPORTS AND PLATES

Field	What it means and what it changes	Default	Limits
Supports	Legs, skirt or on slab (horizontal tanks: saddles). Changes the support design, the wind and overturning checks, and the anchors. Legs, rings, pads, skirt, base ring, chairs and bolts are sized on the final weight. Not designed (plain message instead of a result): a flat or sloped bottom on a skirt, and a formed or cone bottom on a slab. A flat bottom on legs needs a beam grid under the plate; a dished or cone bottom is the usual choice.	by template	–
Leg attachment	Pads plus two support rings (calculated by the tool) or plain pads (local shell stress to be checked by the engineer, WRC 537 or FEA).	Pads + 2 rings	–
Number of legs, Leg pipe size	Shown in Design by the client mode, vertical tanks on legs. Auto lets the tool choose from the load and slenderness.	auto	3, 4, 6 or 8 legs; NPS 2 to 8
Skirt thickness, mm	Shown in Design by the client mode on a skirt.	auto	3 to 20
Material	SS316L, SS304 or carbon steel (CS). Sets allowable stress, plate prices, welding process and finish options.	by template	–
Plate stock, W × L mm	Plate size the shell is cut from. Sets the number of courses, plates per course and the weld length.	1500 × 6000 SS, 1800 × 6000 CS	–
Rolling and forming	In our shop, or Subcontractor. Subcontracted rolling is shown as a vendor item unless you type the roller's rate per kg.	In our shop	–
Plate thickness	Minimum calculated: the tool selects the next stock plate above every requirement. Custom: you type shell, bottom and roof thicknesses; a value below the minimum fails its check and the minimum is used instead (Design by the client keeps it).	Minimum calculated	–
Corrosion allowance, mm	Added to every pressure-part thickness and checked on nozzle and manway necks.	by template	0 to 6 (up to 3)

3.5 SERVICE CONDITIONS AND FINISH

Field	What it means and what it changes	Default	Limits
Liquid density, kg/m³	Sets the hydrostatic load. Water (1000) is used if the product is lighter, so the hydrotest also governs.	by template	500 to 2000 (700 to 1850)
Design temperature, °C	Reduces the allowable stress and modulus of stainless steel above ambient.	by template	−20 to 260 (0 to 95)
Wind, km/h (0 = indoor)	API 650 basic wind speed. With AS 1692: wind region, terrain category and return period replace it.	0 dairy, else 160	0 to 250
Finish	Polish, pickle and passivate (stainless) or blast and paint. Changing the material sets it (and CA 0 for stainless); a painted stainless tank or a CA above 1 mm on stainless gives a yellow warning.	by material	–
Insulation, mm; Insulation extent	Hygienic tanks: PU foam with stainless cladding; other tanks: mineral wool with aluminium cladding. Full tank or shell only. Adds weight, cost and man-hours.	0	0 to 200 (25 to 100)

3.6 PROCESS OPTIONS

Field	What it means and what it changes	Default	Limits
Agitator	None, top entry (centre) or side entry. The tool adds the mounting nozzle and pad, checks the mount and lists the agitator itself as a vendor item. Vertical tanks only.	top for dairy	–
Agitator power, kW	Sets the nozzle size and the mounting check.	0.75	0.18 to 15 (0.25 to 5.5)
Cooling jacket	None, dimple plate or half pipe. Adds jacket plate or pipe, welds, a separate jacket pressure test and its connections. Vertical tanks only.	None	–
Jacket height, % of shell	Share of the shell height covered by the jacket. The jacket stays clear of the leg pads, support rings and lifting lugs; if less is free, the tool warns and uses what fits, and stops below 300 mm. Shell nozzles in the jacket zone get cut-outs (warning).	75	20 to 95 (40 to 90)



Figure 3.3 Options, from left: 75 mm insulation with cladding, dimple jacket with top agitator, side-entry agitator.

3.7 NOZZLES

Each opening is a card in the **Nozzles** tab. Marks starting with M are manways. Empty fields take the engine's automatic value, shown in grey.

Field	What it means and what it changes	Default	Limits
Mark, Service	Tag and duty, for example N2 Outlet. The service picks the default type and flange.	by template	–
Size	NPS 1/2 to NPS 24.	by service	–
Location	Top / roof, shell high, shell, shell low, or bottom.	by service	–
Type, Flange class	By service (auto), slip-on, weld neck, clamp or coupling; Class 150 or 300.	auto	–
Angle, °	Plan angle clockwise from north. Horizontal tanks: 0 = top, 90 = side, 180 = bottom, viewed from the left end.	auto, clear of seams and lugs	0 to 360
Position, mm	Shell: elevation above the shell bottom. Roof: distance from the centre. Horizontal: distance from the left tangent line.	auto	inside the shell or roof
Projection, mm	From the shell or head outside to the flange face.	by size	50 to 500

3.8 WORKSHOP RATES

Field	What it means and what it changes	Default	Limits
Currency, Rate per 1 USD	Currency of every cost and price. The database is in US dollars; the rate converts it.	AUD, 1.4706	> 0
Shop labour, Engineering, NDT (per hour, all-in)	Your three all-in labour rates. Man-hours are multiplied by the rate of their group.	110 / 150 / 160 AUD	equivalent 10 to 300 USD/h
Contingency, %	Added to the direct cost for unknowns.	10	0 to 50 (5 to 25)
Markup, %	Profit on cost: price = cost × (1 + contingency) × (1 + markup), rounded up to the next 50.	15	0 to 50 (5 to 30)
Crew, Hours / week	Workshop crew and working week. Change the duration only.	4, 38	1 to 20; 20 to 84 (36 to 60)

3.9 EDITING THE RESULT

In the **Cost** tab every material cost and every activity's man-hours can be typed over. Press Enter to apply. Edited values are marked in the report, and a value more than 50 % away from the tool's figure raises a yellow warning.

> **What the tool never lets you do.** It never accepts a plate thinner than the calculated minimum without a failed check, never prices a vendor item it has no data for (it lists it in red instead), and never changes your typed nozzle positions; it warns when they clash with a seam, a lug or another nozzle.

CHAPTER 4

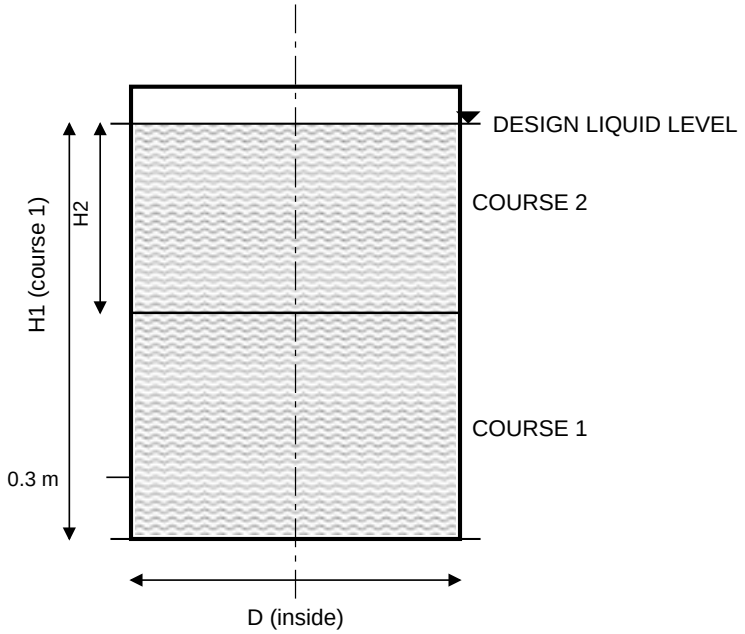
CALCULATIONS

The calculation report follows the order below. Each row shows the formula, the numbers put into it and the result, so an engineer can check it by hand. The methods are the selected methods of the chosen standard for shop-built atmospheric tanks; where the tank is outside a standard's scope (for example a suspended bottom on legs), the report says so and states the method used.

4.1 DESIGN DATA

Tag, service, standard, orientation, material, inside diameter, shell height, closures, geometric capacity, design liquid level, specific gravity G = max(1.0, density / 1000), design pressure (atmospheric, full of liquid), design temperature, corrosion allowance CA, joint efficiency E = 0.85 (spot radiography) and the allowable design stress Sd.

4.2 SHELL THICKNESS



ONE-FOOT METHOD (API 650)

For each course, H is the height from the bottom of the course to the design liquid level. Flat bottom: stress point 0.3 m above the course bottom.

```
td = 4.9 D (H-0.3) G / (Sd E) + CA
tt = 4.9 D (H-0.3) / (St E)
```

Adopted: next stock plate
≥ max(td, tt, minimum nominal)

D in m, H in m, Sd and St in MPa, t in mm

Figure 4.1 Shell courses and the design liquid level. The lowest course carries the largest head.

Quantity	Formula
Design thickness td	`4.9 D (H - h0) G / (Sd E) + CA`
Test thickness tt	`stainless: 4.9 D (H + x - h0) / (St E), AS 1692 x = 1 m; carbon steel: AS 1692 with Sd, API 650 hydrotest check only`
Reduction h0	`0.3 m only where a flat (or one-way sloped) bottom restrains the shell foot; 0 for formed and cone bottoms and for horizontal tanks`
Minimum nominal	`standard table for the diameter (+ CA where the standard requires)`
Check (corroded)	`4.9 D (H - h0) G / (tn - CA) ≤ Sd E`

4.3 HEADS, BOTTOM AND ROOF

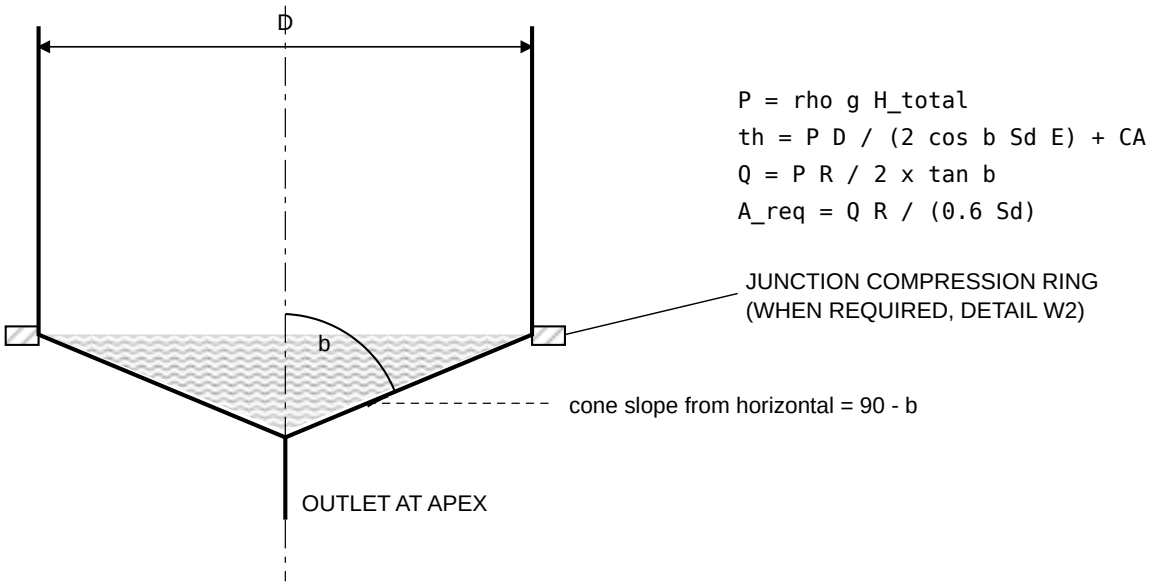


Figure 4.2 Cone bottom. b is the half apex angle; H_total is measured from the apex, so it includes the cone depth.

Quantity	Formula
Pressure at the lowest point	`P = max(density, 1000) × 9.81 × H_total; AS 1692: the larger of the product to the design level and water to the top plus 1 m (test head of clause 2.8.2)`
Formed bottom or head	`th = P D M / (2 Sd E) + CA, then × 1.1 forming thinning; M = 1.54 torispherical, 1.0 ellipsoidal`
Formed head minimum	`standard minimum + CA, and t - CA ≥ 0.002 L (L = D torispherical, 0.9 D ellipsoidal); horizontal heads at most one plate step thinner than the shell`
Cone bottom	`th = P D / (2 cos b Sd E) + CA, not less than the minimum + CA`
Cone/shell junction	`Q = P R / 2 tan b ; A_req = Q R / (0.6 Sd) ; A_av = 0.78 √(R t) t for cone and shell, corroded; ring added for the shortfall`
Flat bottom	`CS: 6 mm + CA ; stainless: corroded thickness ≥ 5 mm`
Top head or roof	`no hydrostatic load: minimum + CA; cone, flat and dome roofs checked for self-weight and roof load`

Automatic selection uses the same total head as the printed check, so a selected bottom always passes its own calculation. A thickness you type below the requirement is not used: the tool keeps the required thickness and marks the check NOT OK. Only in Design by the client mode is the typed thickness kept, as a point to raise with the client.

4.4 NOZZLES, MANWAYS AND REINFORCEMENT

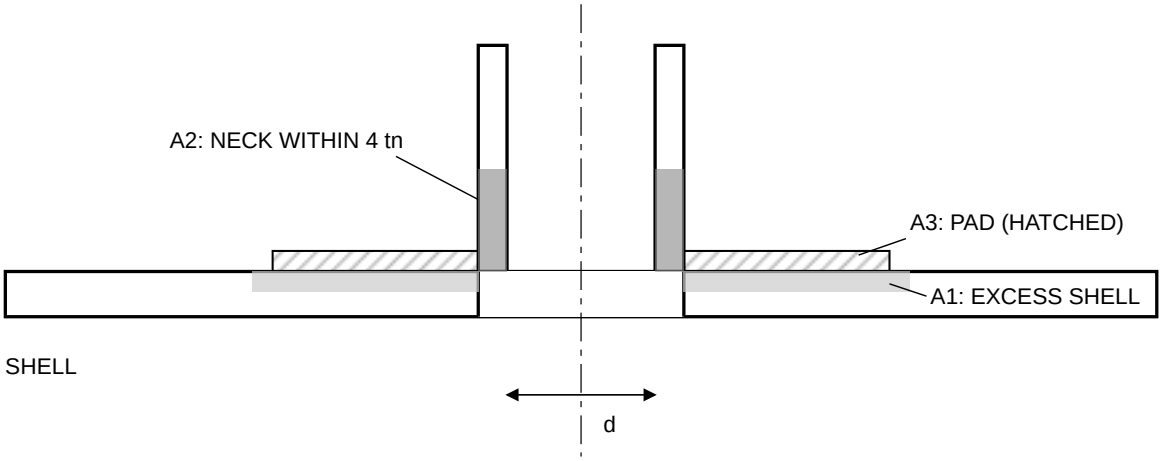


Figure 4.4 Area replacement for a shell opening. The area removed (d × t_req) must be replaced by A1 + A2 + A3.

Quantity	Formula
Shell openings > NPS 2	`A_req = d × t_req (t_req at the opening's own liquid head) ; A_av = d (tn - CA - t_req) + 2 × min(4 t_neck, 8 tn) (t_neck - CA) + pad`
NPS 2 and smaller	`exempt from reinforcement (API 650 5.7.2.1); neck wall still checked`
Openings in a formed or cone bottom	`area replacement at the pressure of the lowest point, plus neck hoop stress P (OD - t) / (2 (t - CA)) ≤ Sd`
Openings in a top head or roof	`above the liquid: no pressure; local load check on the parent plate`
Horizontal tanks	`every opening is below the liquid (design level = full diameter); head at the opening's lowest edge = R (1 - cos a) + OD/2 |sin a|`
Neck walls	`after 12.5 % mill tolerance and CA ≥ 1.5 mm; manway necks keep their table minimum after CA`
Shell manway cover and ring	`standard table entered with the equivalent head = liquid height × max(G, 1); above 8 m the table thickness is scaled by √(head / 8) and marked open for the engineer`

4.5 WEIGHTS AND CENTRE OF GRAVITY

Empty, operating (normal fill), full of product to the design level and hydrotest (full of water) weights, each from the material take-off. Centres of gravity are estimated from part elevations and reported for information; the weights size the supports and the lifting lugs.

4.6 WIND

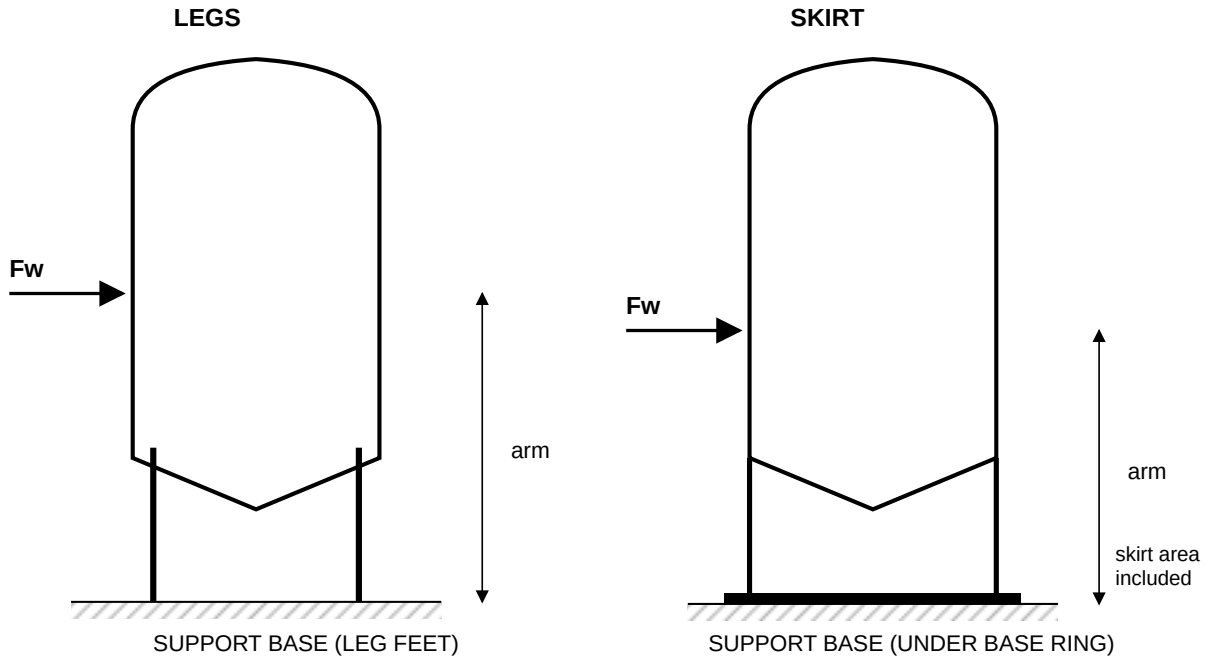


Figure 4.3 Wind force and the support base. Every overturning moment, including those for the skirt, base ring and anchors, is taken about the support base.

Quantity	Formula
API 650	shell 0.86 kPa and roof uplift 1.44 kPa at 190 km/h, scaled by (V / 190)²
AS/NZS 1170.2	Vdes = VR (× 1.05 region C, 1.10 region D, for R of 50 years or more; regional speed confirmed where the map shows subregions) Md Mz,cat, not less than 30 m/s ; q = 0.6 Vdes² ; shell Cfig 0.63 ; roof Cp,e mean 0.65
Force	Fw = Pws × projected area (for a skirt, down to the base ring)
Moment at the support base	Mw = Fw × arm (+ roof uplift moment, vertical tanks)

4.7 SUPPORTS

Quantity	Formula
Legs, axial	KL = 2 × free length ; λ = KL / (r π) √(fy / E) ; P_all = A fy / (1.67 (1 + λ²))
Legs, wind	P_ot = 4 Mw / (n Dc) ; P / P_all + fb / (0.66 fy) ≤ 1 ; uplift when empty > 0 needs anchored base plates
Leg pads	pad length chosen from 300 to 1000 mm so that the leg-to-pad welds and the shell shear pass; the legs, rings and drawings use the same length
Leg rings and welds	rings at the top and bottom of the pad; radial couple F = Pd (e + t/2) / hr; ring bending, leg-to-ring welds, ring-to-shell welds (stitch 1/3, 1/2 or continuous), shell bearing; anchor bolts M16 to M30 from the uplift
Skirt	W / A + Mw / Z ≤ allowable with the section reduced at the access opening and yield at temperature; skirt-to-head weld; base ring and anchor bolts increased until bearing, ring bending and bolt stress pass
Flat bottom on legs	plate between beams; beams for bending, deflection L/360, wall ≥ 3 mm, compact flange and web, and web shear at the end clips
Final weight	supports are sized on the finished empty weight; if jacket, insulation or welds make the tank heavier than the sizing weight, the whole model is run again
Saddles (horizontal)	Saddle stress analysis: longitudinal bending, shear, horn stress, wear plate edge, ring compression at the saddle and, when A ≤ R/2, head shear and head stress; wear plate b + 1.56 √(R t) wide; the shell is thickened until all pass, otherwise the tool stops

4.8 LIFTING LUGS AND ANCHORAGE

Quantity	Formula
Lug load	2 × empty weight shared by the lugs, sling at 60°, safety factor 4 on ultimate
Lug plate	net tension, tear-out and pin bearing
Lug-to-pad welds	full moment from both components: vertical tank M = Fv b/2 + Fh |h/2 - a|; horizontal tank M = Fh (b - a); combined stress ≤ 0.6 Fe / 4; the lug size is raised until it passes
Pad-to-shell weld and shell	weld group with the moment including the pad thickness; shell shear around the pad; local shell bending left open for the engineer
Overturning, tank on slab	resisting weight = corroded shell and roof only (no bottom, no liquid); anchor chairs and bolts chosen from 4 × M24 up to 8 × M30

4.9 AGITATOR, JACKET AND HYDROTEST

Quantity	Formula
Agitator mount	nozzle and pad sized from the power; weld and wall checked on the corroded wall; local loads (WRC 107 / 297 or FEA with the vendor's loads) open for the engineer
Cooling jacket	plate or half pipe sized for 3 bar g, panel stress on the corroded shell; separate jacket pressure test. The jacket is pressure equipment: AS 1210 (dimple plate by clause 3.16.6, half pipe by clause 3.23), hazard level and registration by the engineer
Hydrotest	full of water to the top of the shell (AS 1692: plus 1 m); shell stress 4.9 D (H - h0) / tn ≤ St E ; 4 h hold, no leaks

4.10 INSPECTION AND NDT BASIS

Every weld in the weld register carries its own inspection requirement, and the priced activities count from the register:

- **Spot radiography** on butt welds that carry liquid head: shell vertical and circumferential seams, bottom head or cone to shell, cone bottom seams and horizontal-tank heads. One spot on vertical seams, one per 60 m of circumferential seams, one on cone seams and one at a thickness change.
- **Visual 100 %** on roof and top-head seams (above the liquid) and flat-bottom seams (leak-checked at the hydrotest).
- **Penetrant** on stainless nozzle, pad-to-shell, lug and dissimilar welds; **magnetic particle** on carbon steel lifting lug welds.

4.11 FROM MODEL TO PRICE

Quantity	Formula
Material	Σ take-off items: plates from geometry and stock size, catalogue items from the database
Man-hours	Σ activities: quantity × crew × hours per unit × modifiers (material, position, thickness) × 1.2 allowance
Labour	engineering MH × engineering rate + shop MH × shop rate + NDT MH × NDT rate
Direct cost	material + labour, rounded up to the next 50
Indicative price	direct cost × (1 + contingency) × (1 + markup), rounded up to the next 50
Duration	engineering and approval, procurement, shop man-hours / (crew × hours per week), testing, dispatch

Every check ends as **OK**, **NOT OK**, **SPECIFIED** (met by the specification, no number), **N/A** or **OPEN** (for the engineer). The report cover states how many checks pass, how many are not OK and how many are open.

CHAPTER 5

OUTPUTS

The result panel has four result cards and seven tabs. Tabs can be put in your own order with **Arrange tabs**.

5.1 RESULT CARDS

Direct cost	Material plus labour at your rates, rounded up to the next 50. Ex-works, excluding vendor items listed in red.
Indicative price	Direct cost with contingency and markup, before tax.
Man-hours	Total, split into engineering, shop and test (NDT, hydrotest, dimensional).
Duration	Weeks from order, for your crew and working week.

5.2 COST

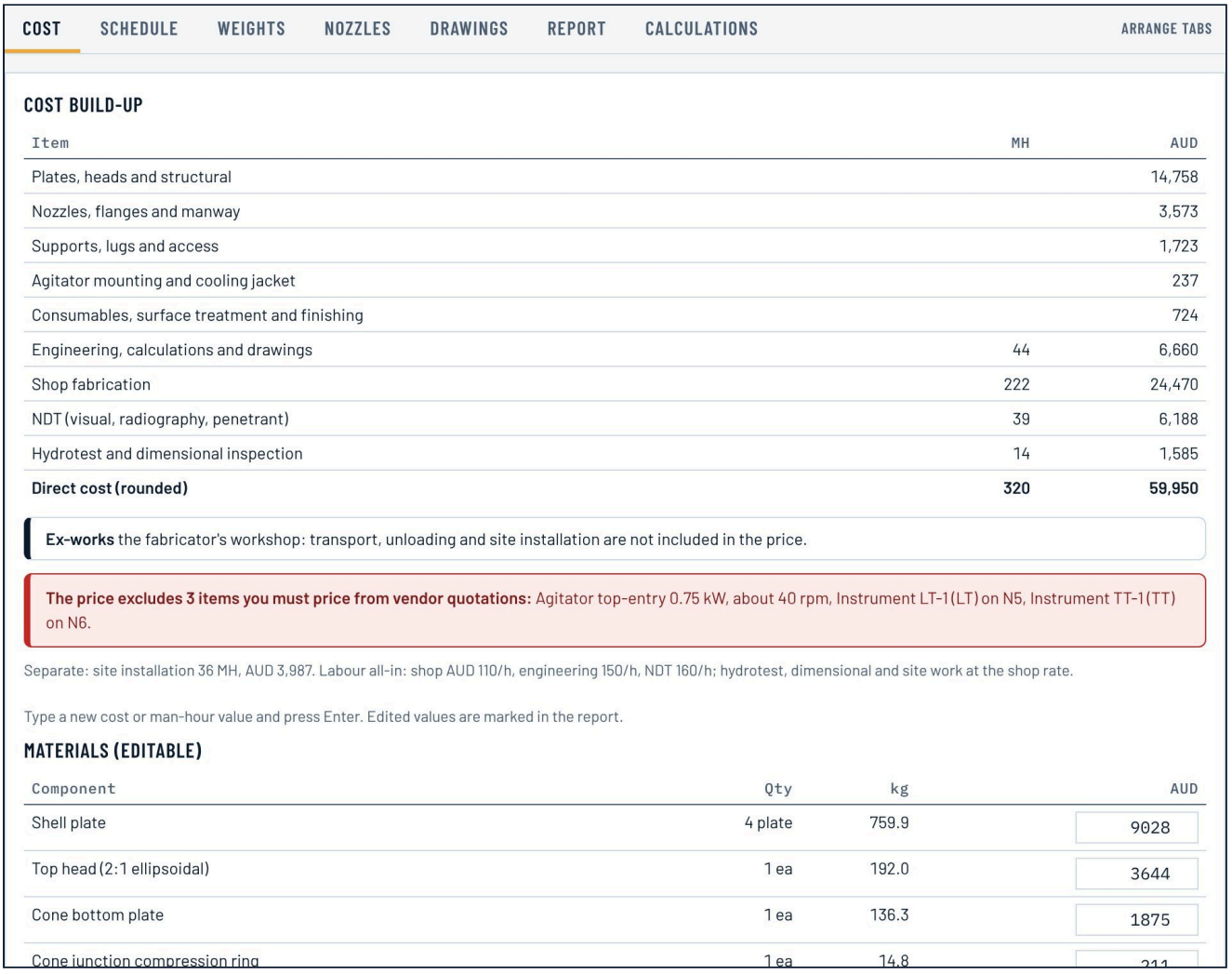


Figure 5.1 Cost tab: build-up, scope notices and the editable material list.

The build-up groups material and labour lines. Below it, every material item and every activity can be edited (Section 3.9). Site installation is shown separately and is not in the price.

5.3 SCHEDULE AND WEIGHTS

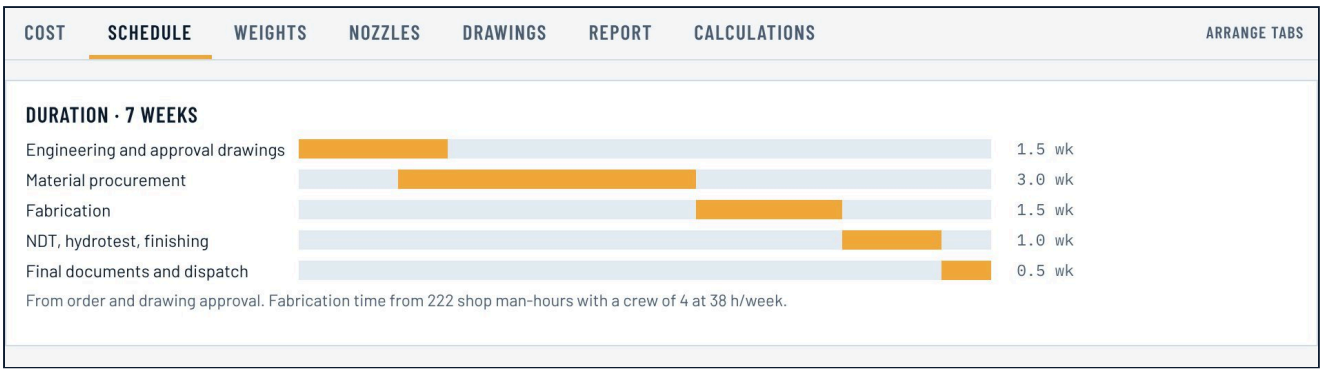


Figure 5.2 Schedule tab: five stages from order to dispatch.



Figure 5.3 Weights tab: empty, operating, full, hydrotest, weld length and plate layout.

5.4 NOZZLES

The nozzle cards (Section 3.7) with a live plan and front elevation. Click a card or a balloon to highlight the nozzle in the 3D model. The same layout prints as the **Nozzle orientation** drawing.

5.5 CALCULATIONS

The design status (calculated checks passed and open items), the notes from the engine, and the full calculation sheet in the order of Chapter 4.

5.6 DRAWINGS

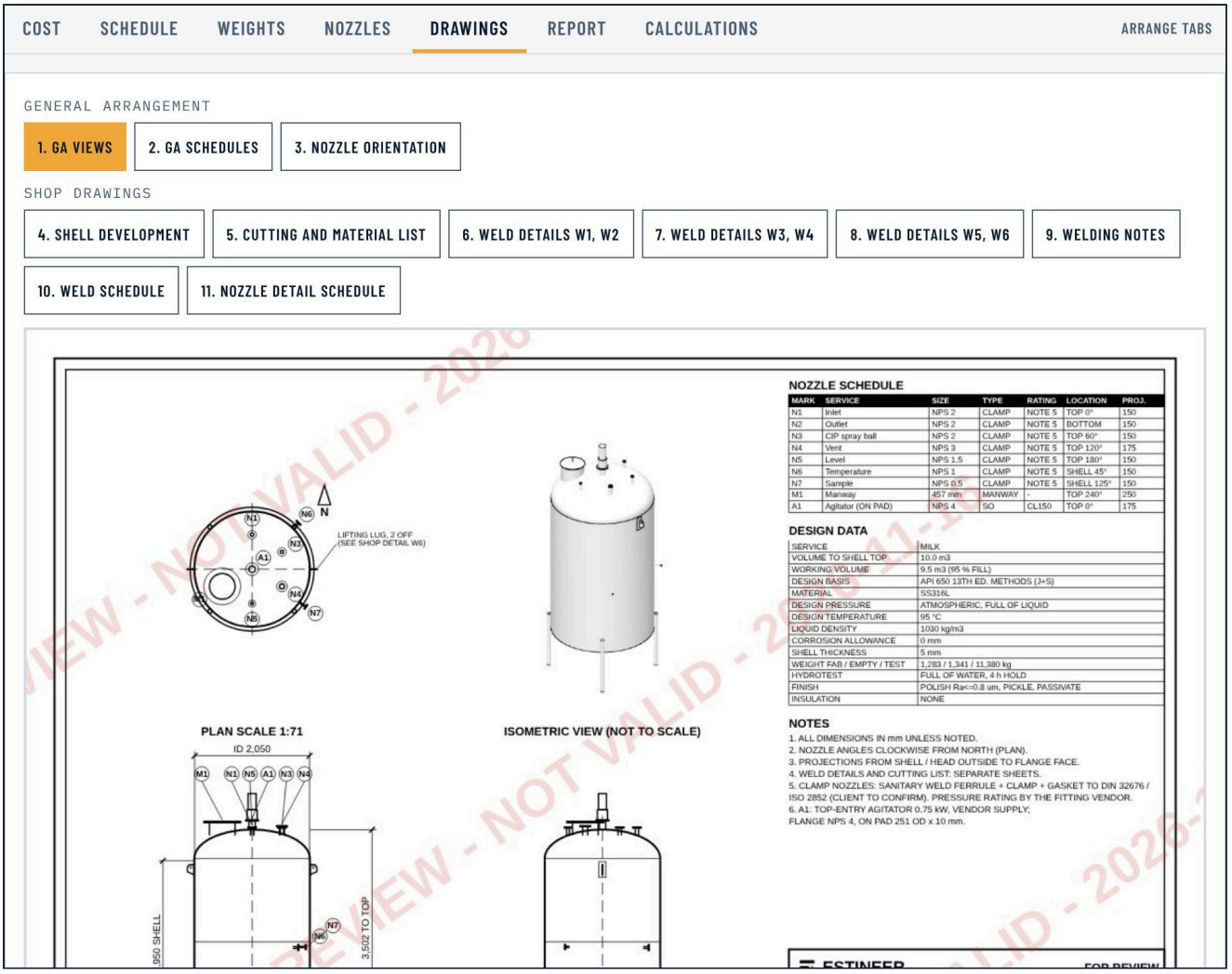


Figure 5.4 Drawings tab. On screen the sheets are low-resolution previews marked PREVIEW, NOT VALID.

Sheet	Content
01 GA views	Plan, elevation, isometric, nozzle schedule, design data and notes
01-2 GA schedules	Nozzle schedule, design data and notes of the GA at a readable size
NO Nozzle orientation	Orientation plan (or end view), developed shell with seams, pads and openings, nozzle table
S01 Shell development	Plates, seams and openings laid flat with dimensions
S02 Cutting and material list	Plate cutting plan and the full material list
S03 to S05 Weld details	W1 to W6: shell seams, bottom to shell, nozzle neck, flange, supports, lug
S06 Welding notes	Processes, consumables, preparation, inspection and finish notes
S07 Weld schedule	Every registered weld: joint, type, size, length, process and NDT
S08 Nozzle detail schedule	Neck, flange or ferrule, pad, projection and weld for each opening

Sheets are A4, numbered with the tag (for example ESTN-T-102-S07) and marked FOR REVIEW.

5.7 REPORT

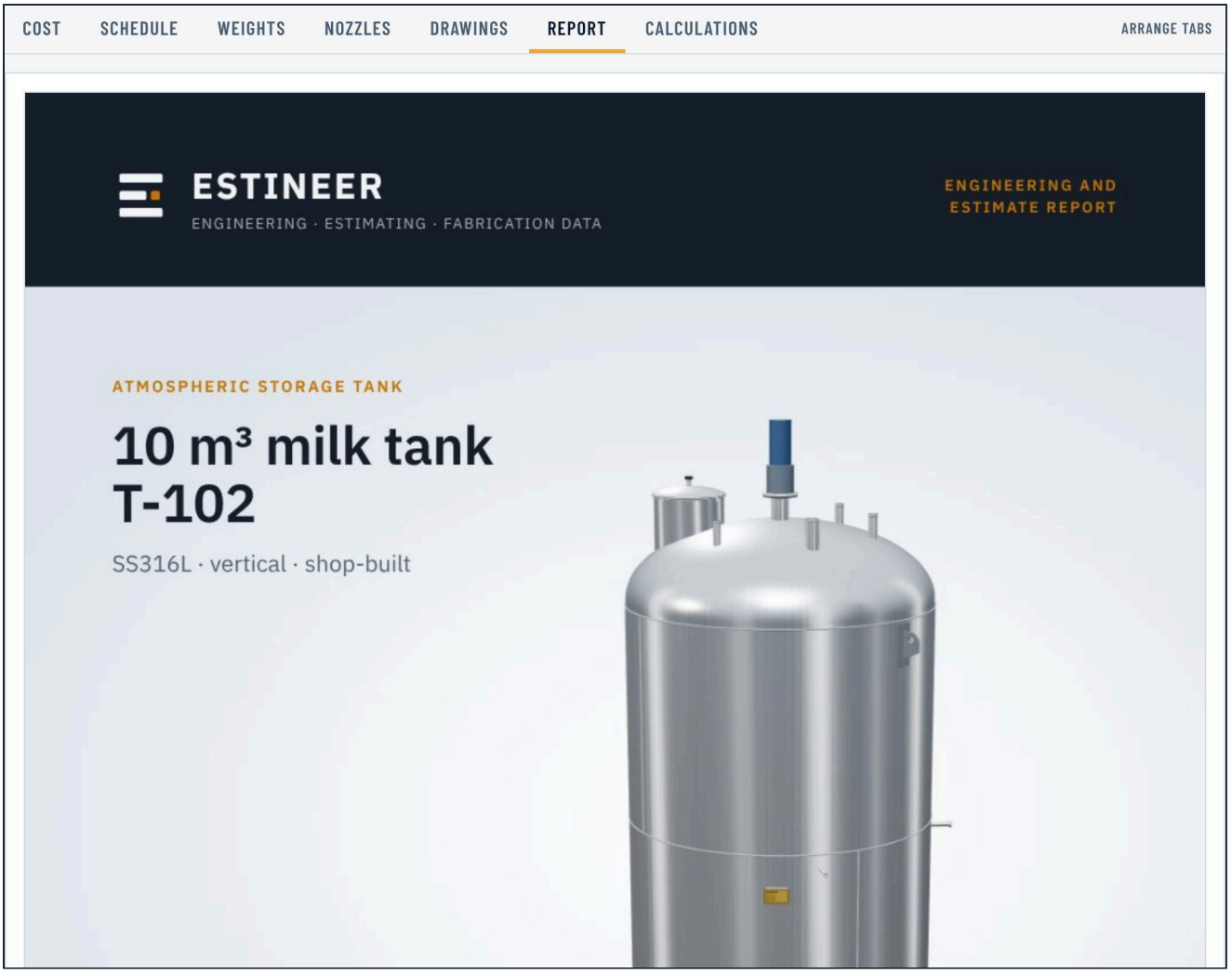


Figure 5.5 Report tab: the cover of the estimate and engineering report.

The PDF report holds the cover (with the 3D picture, ids and the full responsibility statement), the estimate (basis, cost build-up, exclusions, schedule, inputs to confirm), the calculation report and all drawing sheets, with bookmarks and a linked contents list.

5.8 FILES

File	What it is
PDF report	The reference document: estimate, calculations and drawings. Searchable text, bookmarks.
Drawings (PDF)	The A4 drawing set on its own.
Excel	Live-formula workbook: inputs as named cells, material and activity tables, cost build-up. Change a rate and the price follows. A working copy only.
Word	Editable report text for your own offer or notes. A working copy only.

> The Excel and Word files state that the PDF report is the basis and that they have no standing on their own.

5.9 IDS AND VERIFICATION

Project id	EP-XXXX-XXXX, one per tank tag.
Report id and revision	ER-XXXX-XXXX Rev A, one per set of inputs; each issued revision also gets a revision code RV-XXXX-XXXX.
Check code	XXXX-XXXX, made from the inputs, the engine version and the database. The same inputs always give the same code.

The ids are printed on the cover, the page footers, under every drawing frame, and in the Excel and Word files. Anyone can enter a report id at **estineer.com/verify** to see whether it is genuine, its date and the tank; prices and the buyer are never shown.

5.10 ON SCREEN AND AFTER PURCHASE

The screen shows every number for free. Drawings on screen are low-resolution and marked PREVIEW, NOT VALID; the Report tab shows the cover only, and the Calculations tab shows the design status, check summary and notes with the full calculation sheet blurred after its first page. After purchase the files are clean and complete, and can be downloaded again for 12 months.

CHAPTER 6

WORKED EXAMPLE

The 10 m³ milk tank T-102 is the tank that loads when the tool opens. Every number below comes from the engine with the inputs in Section 6.1, engine version 1.64; you can reproduce them on screen.

6.1 INPUTS

Field	Value
Template, liquid	Milk / dairy, milk, hygienic
Capacity	10 m³, vertical
Closures, supports	2:1 ellipsoidal top, 15° cone bottom, 4 legs with pads and 2 support rings
Material, finish	SS316L, polish, pickle and passivate
Density, temperature, CA, wind	1030 kg/m³, 95 °C, 0 mm, indoor
Agitator, jacket	top entry 0.75 kW, none
Nozzles	N1 inlet, N2 outlet, N3 CIP spray ball, N4 vent, N5 level, N6 temperature, N7 sample, M1 manway NPS 18
Rates	shop 110, engineering 150, NDT 160 AUD/h; contingency 10 %, markup 15 %; crew 4, 38 h/week

6.2 GEOMETRY THE TOOL CHOSE

Item	Value
Inside diameter × shell height	2,050 × 2,950 mm
Geometric capacity	10.04 m³
Shell	5 mm, 2 courses of 2 plates from 1500 × 6000 stock
Design liquid level from the apex	3,225 mm
Cone bottom / top head	5 mm / 5 mm
Legs	4 pipe legs NPS 2-1/2, 1,175 mm long

6.3 DESIGN CHECKS

The calculation report gives the full working; the summary is below.

Check	Value	Limit	Result
Shell hoop stress ratio (corroded)	0.06	1.00	OK
Cone bottom thickness	5.00 mm	1.17 mm	OK
Cone/shell junction area	819.72 mm2	819.72 mm2	OK
N2 bottom opening reinforcement	335.62 mm2	4.15 mm2	OK
M1 manway in top head (local load)	0.28 MPa	58.83 MPa	OK
Leg axial (full of product to design level)	0.68	1.00	OK
Leg axial + bending (full of product + wind)	0.68	1.00	OK
Leg-to-pad fillet welds	17.55 MPa	144.00 MPa	OK
Shell shear at leg pad	9.55 MPa	58.83 MPa	OK
Leg support ring bending	83.62 MPa	97.08 MPa	OK
Leg-to-ring welds	7.92 MPa	144.00 MPa	OK
Ring-to-shell stitch welds	32.90 MPa	144.00 MPa	OK
Shell bearing at the lower leg ring	11.20 MPa	132.38 MPa	OK
Leg uplift, empty + wind (no anchors needed)	-3.29 kN	0.00 kN	OK
Lifting lug 120 × 10 plate and welds	OK	SF 4 on ultimate	OK
Lug pad weld and shell shear	0.13	1.00	OK
Local shell bending at lifting lugs	not calculated	engineer	open
Agitator mount	OK	pad on wall	OK
Hydrotest shell stress	5.93 MPa	131.75 MPa	OK

Example by hand, cone bottom: P = 1030 × 9.81 × 3.225 = 32.6 kPa; th = 0.0326 × 2,050 / (2 × cos 75° × 130 × 0.85) = 1.17 mm, so the 5 mm minimum thickness of the standard governs and the adopted plate is 5 mm.

6.4 COST AND PRICE

Line	MH	AUD
Plates, heads and structural		14,758
Nozzles, flanges and manway		3,573
Supports, lugs and access		1,723
Agitator mounting and cooling jacket		237
Consumables, surface treatment and finishing		724
Engineering, calculations and drawings	44.4	6,660
Shop fabrication	222.5	24,470
NDT (visual, radiography, penetrant)	38.7	6,188
Hydrotest and dimensional inspection	14.4	1,585
Material + labour	319.9	59,917
Direct cost (rounded up to 50)		**59,950**
Contingency 10 %, markup 15 %		× 1.10 × 1.15
Indicative price (rounded up to 50)		**75,850**

Check: 59,950 × 1.10 × 1.15 = 75,837, rounded up to 75,850 AUD.

Not in the price: Agitator top-entry 0.75 kW, about 40 rpm, Instrument LT-1 (LT) on N5, Instrument TT-1 (TT) on N6. Transport, unloading and site installation are also excluded (ex-works).

6.5 WEIGHTS AND DURATION

Item	Value
Empty / operating / full / hydrotest	1,341 / 11,164 / 11,681 / 11,380 kg
Weld length	66 m
Duration	7 weeks from order: engineering 1.5, procurement 3 (starts in week 1, overlapping engineering), fabrication about 1.5, testing 1, dispatch 0.5

CHAPTER 7

LIMITS AND REFERENCE

7.1 LIMITS

- Atmospheric tanks only: no internal pressure or vacuum design. Jackets are designed for 3 bar g on their own side.
- Capacity 0.5 to 100 m³, diameter 0.6 to 4 m, shell height 0.5 to 12 m.
- Seismic loads (API 650 Annex E or AS 1170.4) are not assessed; foundations, anchor setting, transport and erection are not included.
- Horizontal tanks are outside API 650: on the API basis the tool uses the same hoop formula with a fabricator minimum (5 mm carbon steel, 3 mm stainless) and says so. They take torispherical or 2:1 ellipsoidal heads only, and no agitator or jacket.
- Normal and emergency vent sizing (fill and withdrawal rates, fire case) needs process data and is listed as an open item.
- Not designed (the tool stops with a message): a flat or sloped bottom on a skirt, a formed or cone bottom on a slab, a cooling jacket with less than 300 mm of free shell, and supports or saddles that fail even at the largest stock size.
- Agitators, instruments, spray balls beyond the budget value, and subcontracted rolling without a rate are vendor items.
- Plain leg pads need the local shell stress checked by the engineer (WRC 537 or FEA). Local shell bending at lifting lugs and local loads at the agitator nozzle are left open for the engineer.
- A cooling jacket is pressure equipment under AS 1210 (the tank itself is not): its design, hazard level and any registration are for the engineer.
- Carbon steel above 93 °C: the API 650 Annex M yield reduction is not applied and the check is marked NOT OK.
- Hygienic rules follow general practice; check them against the 3-A or EHEDG documents that apply to your project.
- Prices are budget level in 2026 dollars and must be replaced by quotations where the report says so.

7.2 QUESTIONS

Why is my thickness larger than the formula gives?

Small tanks are usually governed by the minimum thickness of the standard, the next stock plate, or a support or nozzle check, not by the hoop stress. The calculation report shows which.

Why does the run stop with a red message?

A value is outside its hard limit (Chapter 3), or the combination is one the tool does not design (Section 7.1). The message says what to change.

A check says NOT OK. What now?

With Minimum calculated thickness the tool fixes most checks itself. A NOT OK usually follows a value you typed (a custom thickness, a nozzle position) or a client design. Change the input, or raise the point with the client.

Why is the agitator not in the price?

It is a vendor item. The tool prices its nozzle, pad and installation, and lists the agitator in the red box so you add the vendor's quotation.

Can I change a man-hour or cost figure?

Yes, in the Cost tab. Your edits are marked in the report, and large changes raise a warning.

Will the same tank give the same price tomorrow?

Yes, while the engine version and database stay the same. The check code changes when either changes.

Who is responsible for the design?

The engineer who checks and approves it. The tool gives engineering data and a cost model, not engineering advice and not a quotation.

7.3 GLOSSARY

Annex J	API 650 annex for shop-built tanks
CA	Corrosion allowance, added to thicknesses
Course	One ring of shell plates
Direct cost	Material plus labour, before contingency and markup
E	Joint efficiency, 0.85 for spot radiography
Ex-works	Price at the fabricator's workshop, before transport
G	Design specific gravity, at least 1.0
GA	General arrangement drawing
Hydrotest	Test full of water before dispatch
Markup	Profit added on cost
MH	Man-hours
MTO	Material take-off: every item with weight and cost
NDT	Non-destructive testing: VT visual, RT radiography, PT penetrant, MT magnetic particle
NPS	Nominal pipe size
Open item	A point the engineer must confirm
Pad	Reinforcing plate around an opening or under a leg or lug
Sd, St	Allowable design and hydrotest stress
SPECIFIED	A requirement met by the specification, with no number to check
Support base	The plane the overturning moment is taken about: leg feet, or under the skirt base ring
Tag	Equipment number, for example T-102
Vendor item	Bought-in item priced from a quotation, not by the tool

7.4 SUPPORT

Email **support@estineer.com** with your report id and check code.