

Rock and Ore Characterization and Circuit Selection Reference

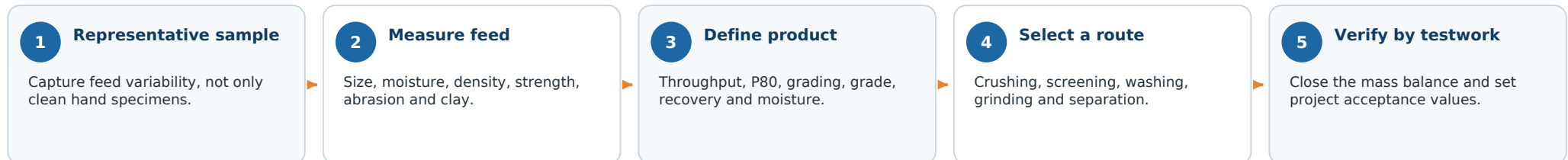
Feed data, test methods, material-specific risks and route selection boundaries

INDUSTRIAL ENGINEERING TECHNICAL REFERENCE



Feed characterization controls every downstream decision

A commercial rock name does not define crusher duty, wear rate, liberation size or separation response. Representative sampling and a documented test program are required before a circuit can be selected or performance can be guaranteed.



USE BOUNDARY Indicative ranges in this reference support screening-level decisions only. Deposit-specific testwork and model-specific equipment data govern final design.

Required Feed Tests

Report the measured value, test method, sample condition and variability. A single average can conceal the condition that controls plant capacity.

Three data groups drive the first circuit decision

SIZE + FLOW

Top size, F80, fines, moisture and bulk density define openings, storage volume and transfer capacity.

BREAKAGE + WEAR

UCS, fracture pattern, abrasion and grindability define breakage duty, stage count and consumable risk.

MINERAL RESPONSE

Mineralogy, grade and liberation by size define whether screening is enough or concentration is required.



Laboratory characterization: sieve analysis, prepared rock cores and compression testing.

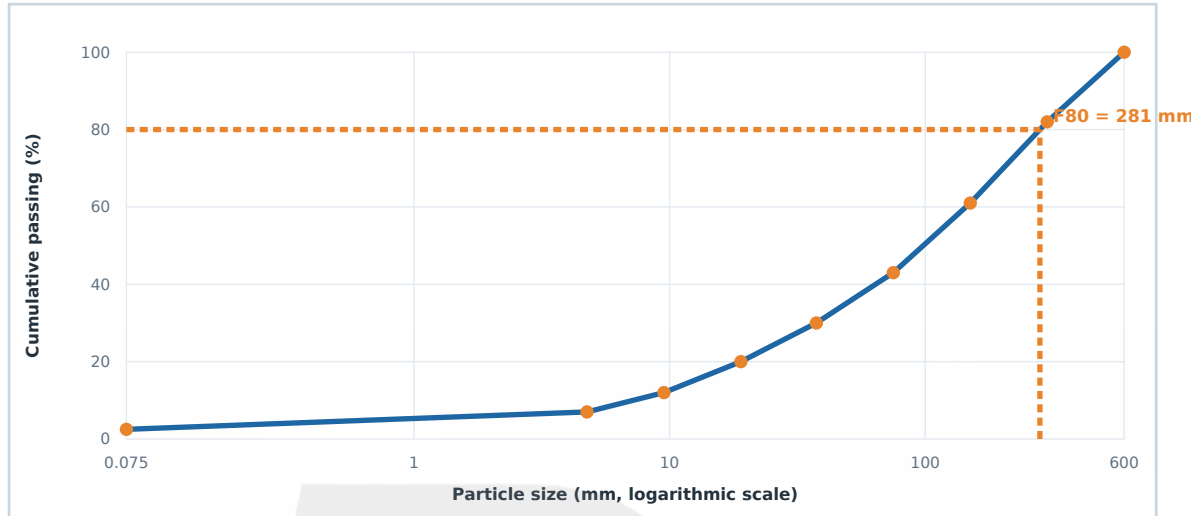
Parameter	Reportable output	Method anchor	Engineering decision	Required qualifier
Feed size distribution	Maximum lump, F100, F80 and complete mass-% passing curve	Sieve analysis; ASTM C136/C136M-25 where aggregate scope applies	Feed opening, stage reduction, screen decks and conveyor duty	State dry or wet basis, sample mass and handling of oversize
Fines and clay	% passing 75 um by washing; clay mineral or activity indicator when relevant	ASTM C117-23 for mineral aggregates; material-specific clay tests	Prescreening, washing, scrubbing, chute slope and blinding risk	Differentiate liberated fines from surface coatings and degradation
Moisture	Mass % water, range and seasonal condition	Gravimetric method appropriate to the material	Flowability, dust, screen efficiency and dry-processing feasibility	State as-received basis and sampling time/location
Bulk density	Loose and, where required, compacted bulk density in t/m ³	ASTM C29/C29M-23 where aggregate scope applies	Hopper volume, feeder speed, belt loading and stockpile volume	Do not substitute solid density for bulk density
Intact rock strength	UCS in MPa plus failure mode and specimen condition	ASTM D7012-23 for intact rock core	Primary crusher duty, chamber loading and breakage uncertainty	Weathered fragments and intact core may give different results
Abrasion / degradation	Bond Abrasion Index, or aggregate degradation loss where applicable	Declared Bond procedure; ASTM C131/C131M-20 for small-size aggregate degradation	Liner, hammer and media consumption; maintenance exposure	LA degradation loss is not equivalent to crusher wear abrasivity
Grindability	Bond Ball Mill Work Index in kWh/t at a stated closing screen	Declared Bond test protocol and apparatus	Grinding power estimate and comparison of circuit options	Do not compare values obtained at different closing screens without review
Mineralogy + liberation	Modal mineral %, assay, associations and liberation by size	XRD, chemical assay and automated mineralogy / microscopy	Concentration route, target grind size, grade and recovery basis	Deposit-specific; report size classes and detection limitations

Test Methods and Engineering Use

Method scope matters. Use an applicable standard where one exists and document every non-standard or material-specific procedure.

Illustrative run-of-mine feed size distribution

Example data demonstrate F80 interpolation only; they are not a design feed for any specific deposit.



Applicable method anchors

- **ASTM C136/C136M-25** Sieve particle-size distribution for fine and coarse aggregates.
- **ASTM C117-23** Material finer than 75 um in mineral aggregate by washing.
- **ASTM C29/C29M-23** Bulk density and voids in aggregate; not solid particle density.
- **ASTM D7012-23** Compressive strength and elastic moduli of intact rock core.
- **ASTM C131/C131M-20** Abrasion and impact degradation of small-size coarse aggregate.
- **ISO 13320:2020** Laser diffraction for fine-particle size distribution within method scope.

Bond work and abrasion tests require the laboratory procedure, closing screen, apparatus and sample preparation to be reported; a standard name alone is not enough.

Representative sample preparation chain



What an incomplete data package can get wrong

Top size only

Hides fines load and the near-size fraction that controls screening.

REQUIRED: RANGE + SAMPLE CONDITION

Dry PSD on clayey feed

Understates coatings and the material likely to blind apertures.

REQUIRED: RANGE + SAMPLE CONDITION

One UCS result

Misses weathering, structure and the strength distribution across the deposit.

REQUIRED: RANGE + SAMPLE CONDITION

Average moisture

Can miss wet-season transfer and dry-screening instability.

REQUIRED: RANGE + SAMPLE CONDITION

Aggregate Rock Selection Matrix

Rock type indicates likely behavior, but silica, weathering, fracture pattern and moisture can move the same commercial material into a different circuit.



Separated, traceable samples are required for comparable test results.

COMPRESSION ROUTE

Preferred for strong, quartz-rich or highly abrasive rock. Control chamber loading and closed-side setting.

IMPACT ROUTE

Useful for higher reduction and cubical shape where silica-related wear remains economic.

WASH / SCRUB ROUTE

Required when clay coatings and plastic fines cannot be removed by dry scalping alone.

Material	Mineral / structure indicator	Typical solid density t/m ³	Indicative UCS MPa	Dominant selection risk	Typical processing route
Limestone	Calcite-dominant; silica and clay vary by deposit	2.55-2.75	20-180	Silica can change a nominally low-wear duty; clay may blind screens	Scalp -> jaw or impact; low-silica feed may suit hammer duty; wash if clay persists
Granite	Quartz + feldspar + mica; jointing controls block breakage	2.60-2.75	100-250	Quartz-driven liner wear; variable slabby feed	Jaw -> cone -> closed-circuit screen; VSI only where shape or sand value justifies wear
Basalt	Fine-grained mafic rock; dense and commonly strong	2.75-3.05	100-300	High strength, dense belt loading and liner wear	Jaw or gyratory -> cone -> screen; verify power and transfer capacity on a dry-tonne basis
Dolerite	Medium-grained mafic rock; texture and weathering vary	2.80-3.10	100-300	Block shape, strength variability and high volumetric loading	Jaw -> cone -> screen; use tested feed gradation and density for bin and conveyor sizing
Quartzite	Interlocking quartz; dominant mineral hardness about Mohs 7	2.60-2.70	100-300	Very high wear potential and difficult tertiary duty	Heavy-duty jaw -> cone in closed circuit; minimize unnecessary impact stages and monitor wear
River pebble	Rounded, source-dependent and often quartz-rich	2.55-2.75	Source-specific	Difficult gripping, high recirculation and wear if quartz-rich	Jaw -> cone -> screen; optional VSI shaping after wear and product-value review
Sand + gravel	Loose mixed particles; clay and organics may dominate behavior	Variable	Not applicable	Coatings, moisture, contamination and degradation	Scrub / wash -> classify -> dewater; crush only oversize or weak product fractions

Data status: indicative engineering ranges. Actual density and UCS are deposit-, weathering- and specimen-specific; representative testing is required.

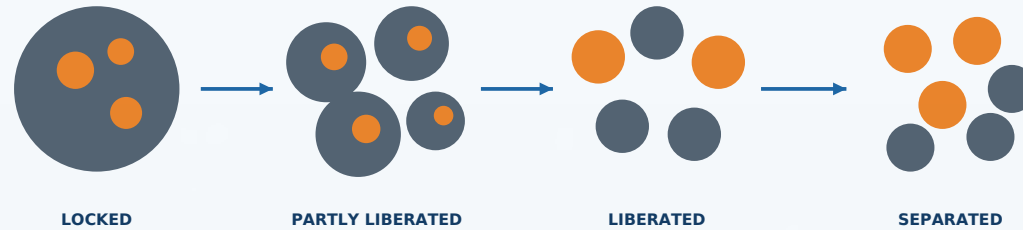
Metal Ore Processing Matrix

Front-end crushing prepares a controlled feed. Liberation, grade and mineral response determine whether grinding and concentration are required.



Crushing and screening create a controlled feed; concentration still requires liberation and separation.

Liberation controls the route beyond crushing



Material	Primary processing objective	Front-end preparation	Typical separation route	Critical test data	Main circuit risk
Gold-bearing ore	Expose free gold or gold-bearing sulfides while controlling slimes	Staged crushing; controlled grind established by mineralogy	Gravity, flotation, leaching or a combined route	Head grade, gold association, liberation by size, BWi, reagent response	Gold locked in sulfides, preg-robbing material or overgrinding
PGM ore	Liberate PGM-bearing sulfides and preserve flotation response	Compression crushing followed by fine, controlled grinding	Flotation, then downstream metallurgical treatment	Modal mineralogy, sulfide association, chromite distribution, liberation	Chromite entrainment, fine valuable-mineral loss and variable hardness
Chromite	Reject silicate gangue while retaining chromite by size	Crush, screen and classify; avoid excess ultrafines	Dense-media and gravity concentration such as spirals or jigs	Size-by-size grade, density response, clay, liberation and slimes	Misplaced fines, slime generation and unstable gravity feed
Manganese	Upgrade lump or fines while limiting product degradation	Controlled crushing, screening and washing where clay is present	Dense-media, jigging or other gravity upgrading	Size-by-size assay, clay, degradation, density response and moisture	Clay contamination and loss of saleable lump into fines
Iron ore	Reject silica and recover iron minerals at the required product size	Crush and screen; grind only where mineral association requires it	Magnetic, gravity or flotation routes depending on mineralogy	Magnetite / hematite split, silica association, liberation, BWi and moisture	Variable hardness, overgrinding and insufficient silica rejection
Coal	Separate low-density coal from higher-density mineral matter	Low-fines crushing, sizing and desliming as required	Dense-media, spirals and fine-coal flotation	Float-sink curve, moisture, size degradation and fine-coal response	Excess fines, unstable medium and difficult dewatering
Diamond-bearing ore	Liberate diamonds while minimizing particle damage	Low-damage staged crushing, scrubbing and screening	Dense-media separation and sensor-based recovery	Size distribution, breakage testing, clay, density response and recovery audit	Breaking large stones or losing diamonds to undersize / discard

No universal liberation size is assigned: it must be measured for the deposit and linked to grade-recovery testwork at defined size fractions.

Circuit Selection Checklist

Use measured feed variability and a defined product basis to select the route. Model-specific capacity follows only after the process basis is stable.

Illustrative stage-count check

Feed F80 = 600 mm Target P80 = 12 mm

Total reduction ratio = 600 / 12 = 50:1

Based on F80 / P80, not maximum feed / nominal setting

Primary jaw

4.0:1

x

Secondary cone

4.0:1

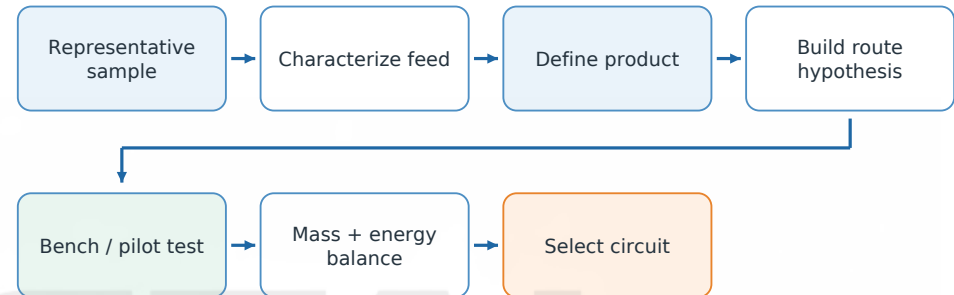
x

Tertiary cone

3.2:1

Combined representative ratio: 4.0 x 4.0 x 3.2 = 51.2:1

Decision sequence



If recovery, wear or handling risk remains unresolved, return to characterization or pilot testing.

Category	Required input	Unit / reporting basis	Project value	Status
Feed	Maximum lump, F100, F80, full PSD, moisture, bulk density, clay, UCS, abrasion and grindability	Dry / wet basis stated; minimum-average-maximum or percentile range		Open / Verified
Product	Required P80, graded fractions, shape, grade, recovery and final moisture	Sieve sizes, assay units and mass basis defined		Open / Verified
Operation	Dry throughput, hours per day, availability, recirculating load and maintenance access	Dry t/h; operating schedule; target availability		Open / Verified
Site	Power, water, elevation, temperature, dust limit, drainage and tailings / waste route	Available utility limits and environmental design basis		Open / Verified
Verification	Bench tests, pilot campaign, mass balance, wear basis and acceptance-test conditions	Method, sample ID, duration, uncertainty and pass / fail basis		Open / Verified

METHOD REFERENCES USED IN THIS GUIDE

ASTM C136/C136M-25; ASTM C117-23; ASTM C29/C29M-23; ASTM C131/C131M-20; ASTM D7012-23; ISO 13320:2020. Each method applies only within its stated scope. Project specifications may require additional commodity-specific sampling, assay and test procedures.