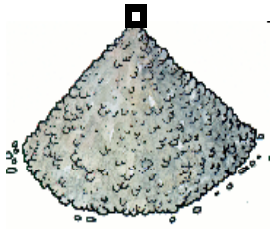
SANDVIK ROCK PROCESSING

THE ART OF CRUSHING

What is a C&S system ?

Feed

Machines & Processes



Products

- Super Quarries & Mines 600-2000 tph
- Medium Quarries 300-600 tph
- Small Quarries & Mobiles 150-300 tph

THE ART OF CRUSHING

- Raw material?
- How big? (Size of rawmaterial)
- How much? (Capacity)
- Final products?
- Contamination?

THE ART OF CRUSHING

- **Feedcurves**
- **Max Topsize**
- **Impact Work index (W_i)**
- **Abrasion index (A_i)**
- **Type of rock / geology**
- **Density**
  - **$W_{i\ measured}$ x B.D./1.6 = $W_{i\ real}$**
- **Moisture**
- **Contamination**

THE ART OF CRUSHING

Crushing Rock

- ✓ Limited reduction
- ✓ Cubical shape
- ✓ Over- and undersize is important
- ✓ Flexibility
- ✓ Crushing and screening
- ✓ Range of products

✓ Sellable Products !

Crushing Gravel

- ✓ Limited reduction
- ✓ Cubical shape
- ✓ Over- and undersize is important
- ✓ Flexibility
- ✓ More screening than Crushing
- ✓ Contamination?
- ✓ Range of products

✓ Sellable Products !

Crushing Ore

- ✓ Maximum reduction
- ✓ Shape of no importance
- ✓ Over- and undersize of no importance
- ✓ Flexibility of minor importance
- ✓ More crushing -less screening
- ✓ One or two products

✓ Product to further processing !

THE ART OF CRUSHING

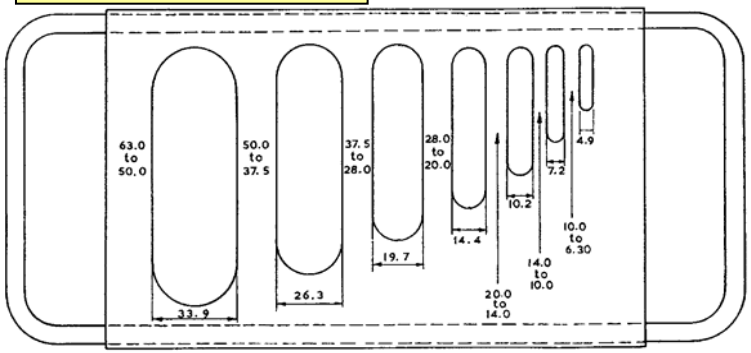
Final Products - Specifications

- Asphalt / Concrete
  - ✓ Shape of material
  - ✓ Over and undersize
  - ✓ No contamination
- Base course / Sub base
  - ✓ Curve limitations
- Railway ballast
  - ✓ Curve limitations
  - ✓ Shape of material
  - ✓ Over and undersize
  - ✓ No contaminations

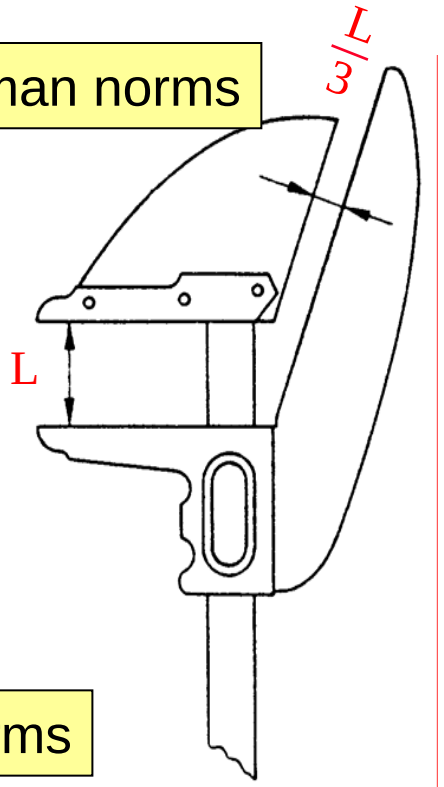
- Different in all countries

Product properties

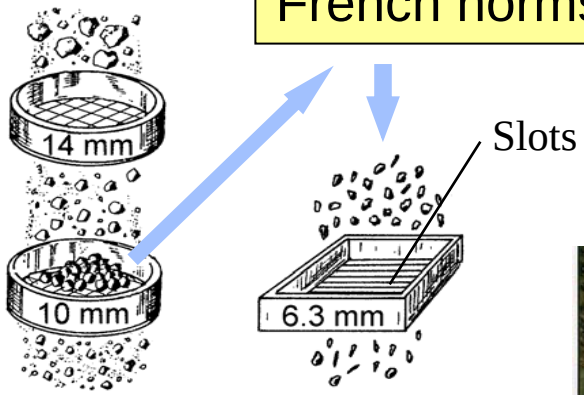
British norms



German norms



French norms



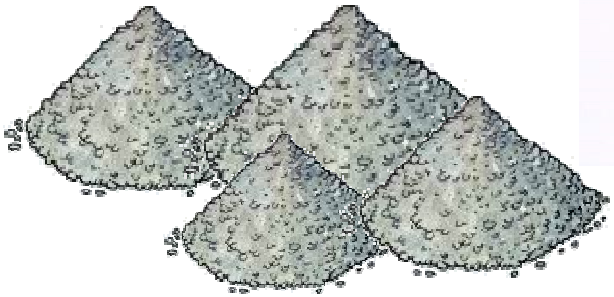
"US" norms

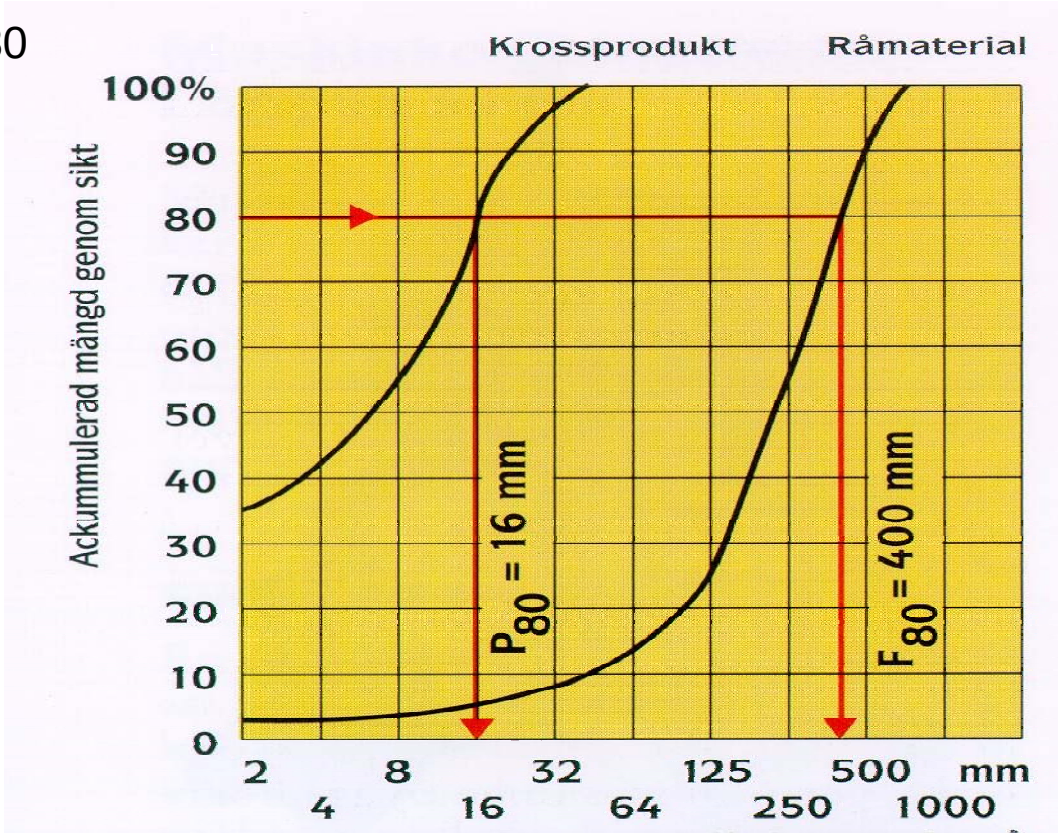
Reduction Ratio (1)

$$Reduction\ Ratio = \frac{F_{80}}{P_{80}}$$

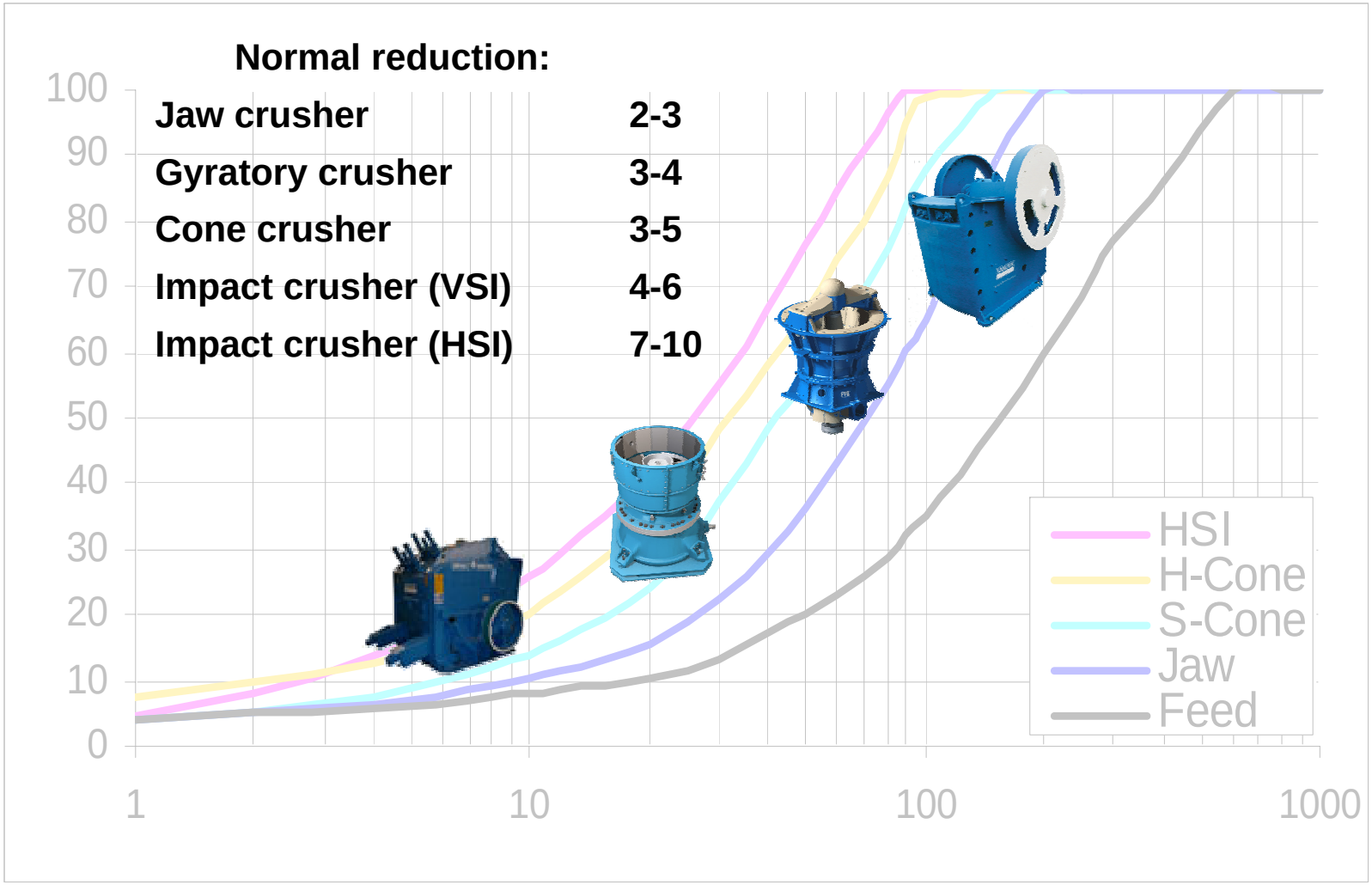
F_{80} = (80 % of feed mtrl)

P_{80} = (80 % of the product)





Reduction Ratio (2)



Reduction Ratio (3)

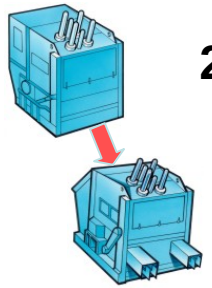
Using reduction ratio to predict required no. of crushing stages

P_{80} Feed: 400 mm

P_{80} Products: 16 mm

Min. required plant reduction ratio:

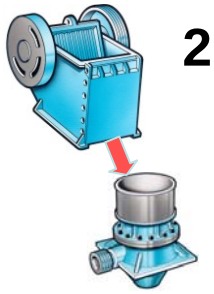
$$\frac{400}{16} = 25$$



2-stage Impact Plant:

10x7=70

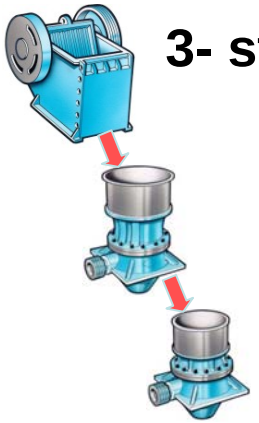
OK, Only for Ai <0.15



2-stage Jaw/cone Plant

3x4=12

NOT OK



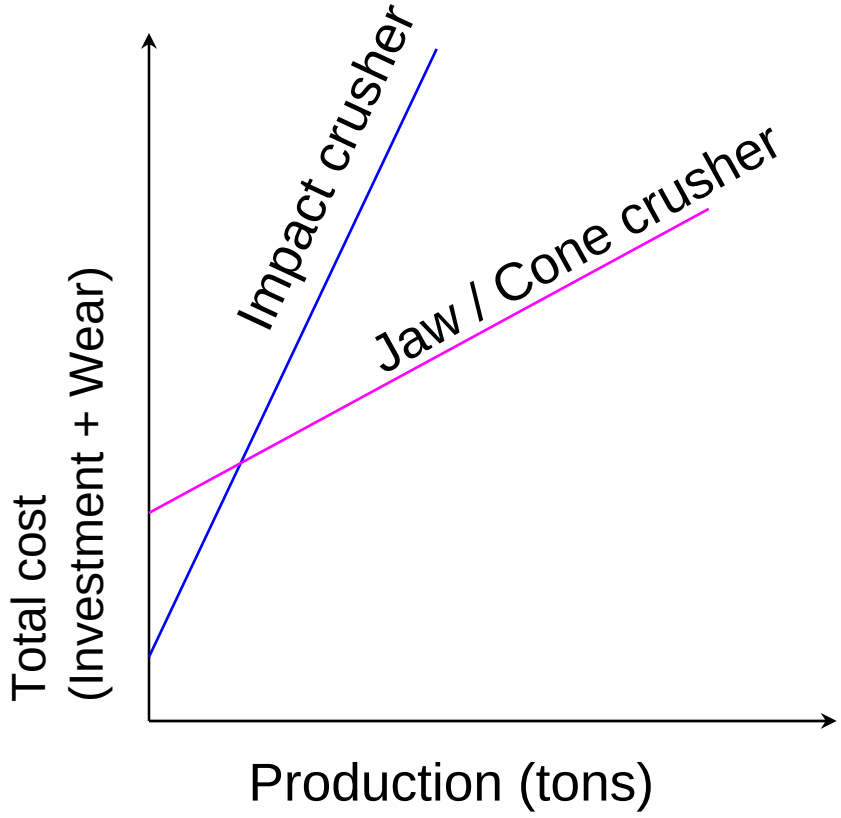
3- stage Jaw/cone Plant

3x3x4=36

OK

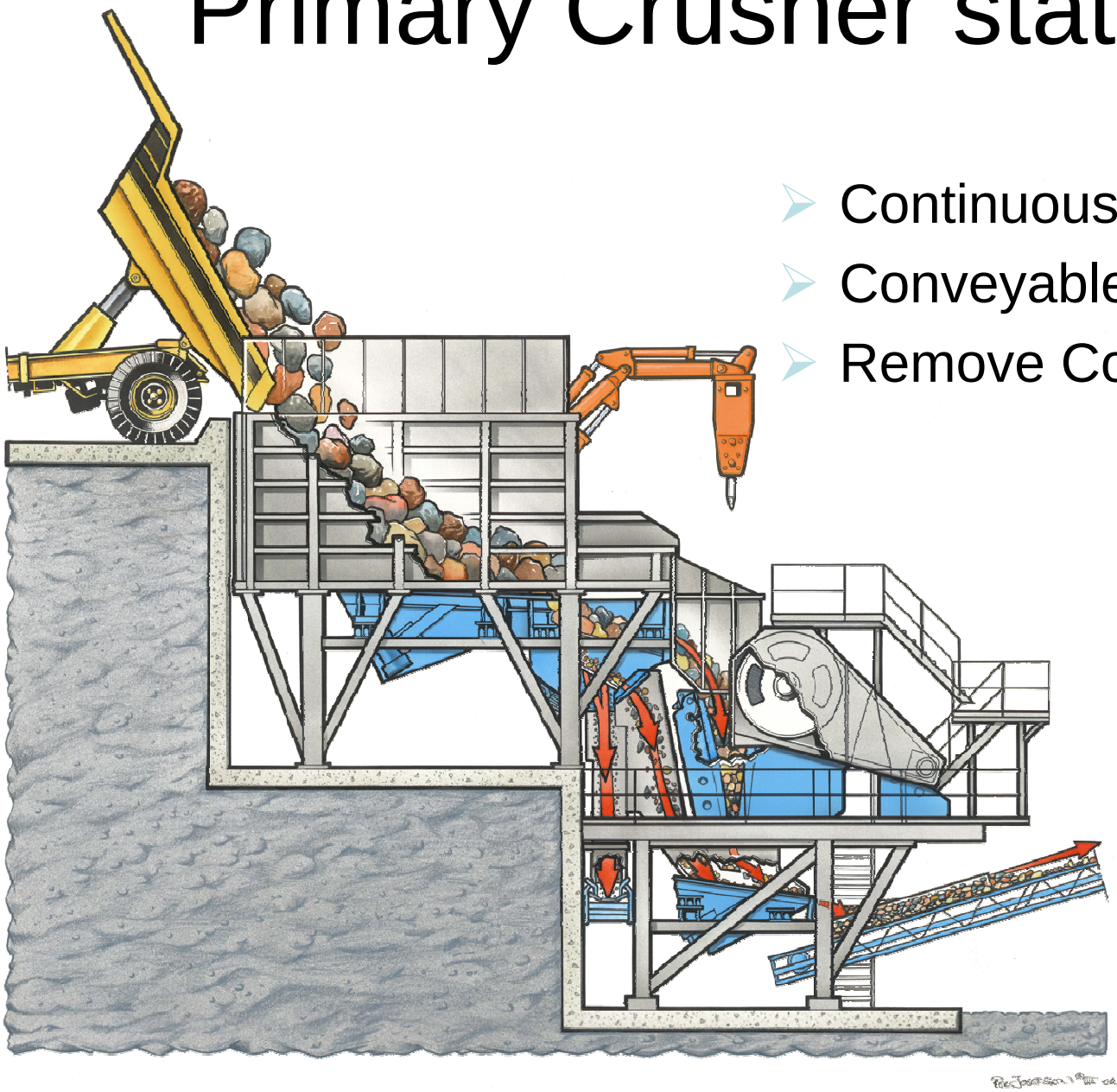
Reduction Ratio 3

Impactors VS Compresive crushers



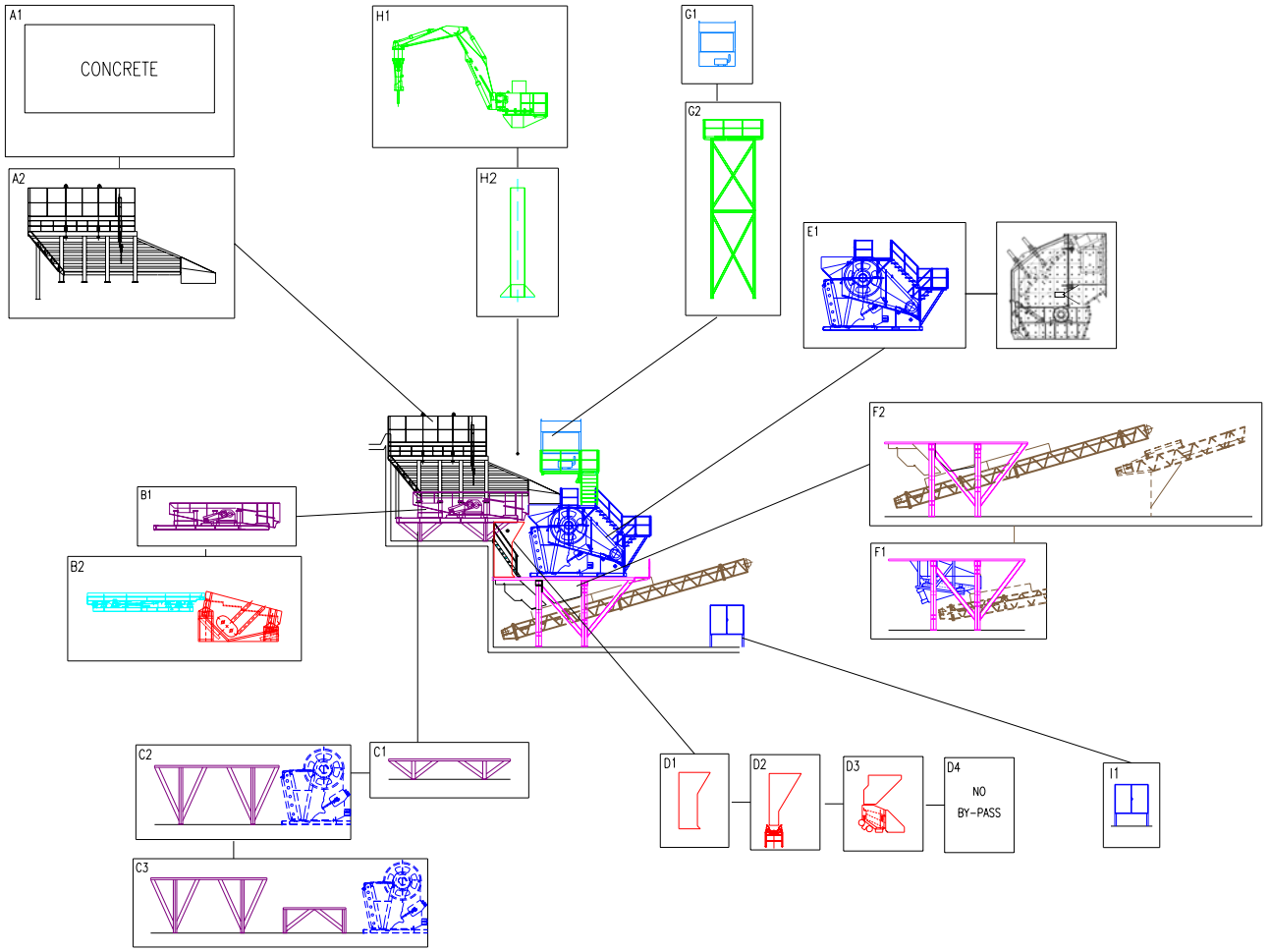
- **Impact crusher**
  - ✓ **High reduction ratio**
  - ✓ **Low investment**
  - ✓ **High wear cost**
  - ✓ **Max A_i= 0.15**
- **Jaw / Cone crusher**
  - ✓ **Low reduction ratio**
  - ✓ **Big investment**
  - ✓ **Low wear cost**

Primary Crusher station



- Continuous process
- Conveyable product
- Remove Contaminations

Primary Crusher station

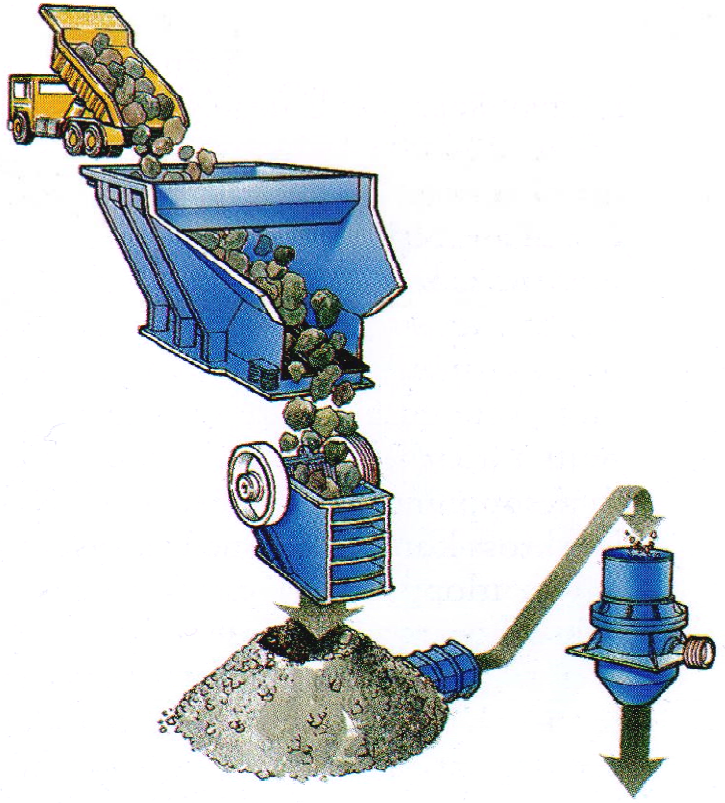


Primary Crusher station

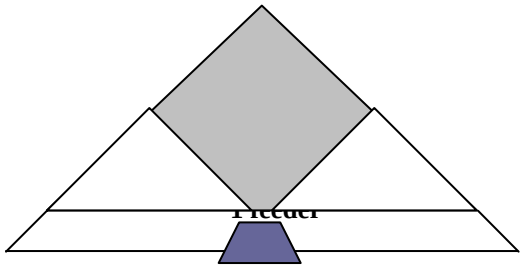
Primary Crusher station

Intermediate storage

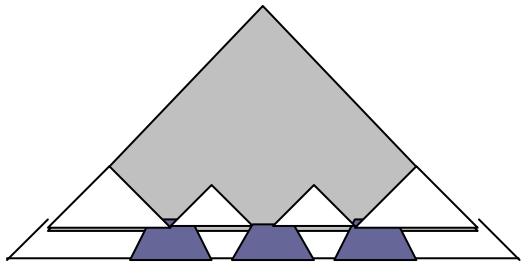
- **Quality producing part of plant independent of Primary crushing and loading operation**
- **Even out variations in the material distribution. Uneven load gives problems in all machines coming after.**
- **Better total availability for the Plant**
- **Recommended stockpile volume for 2 shifts operation**



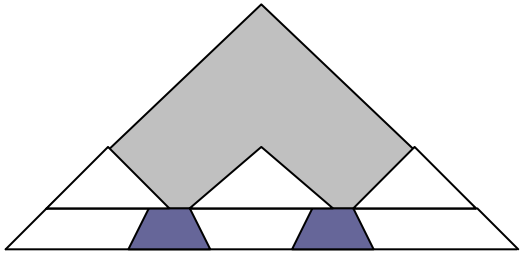
Intermediate Storage (2)



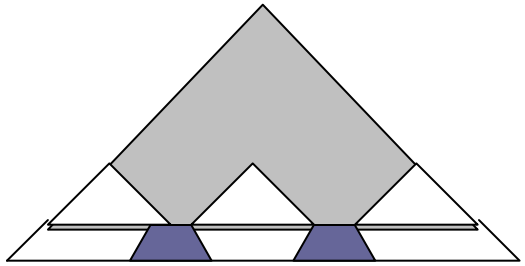
1 feeder



3 feeders



2 feeders



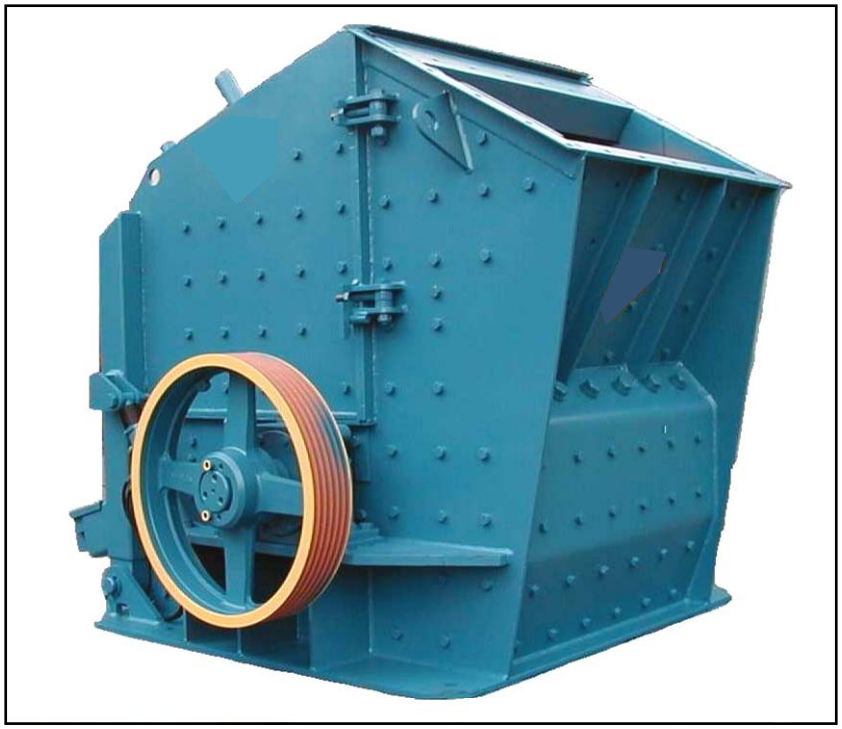
4 feeders

Secondary Circuit

- Big feed opening
- High capacity
- Controlled feed

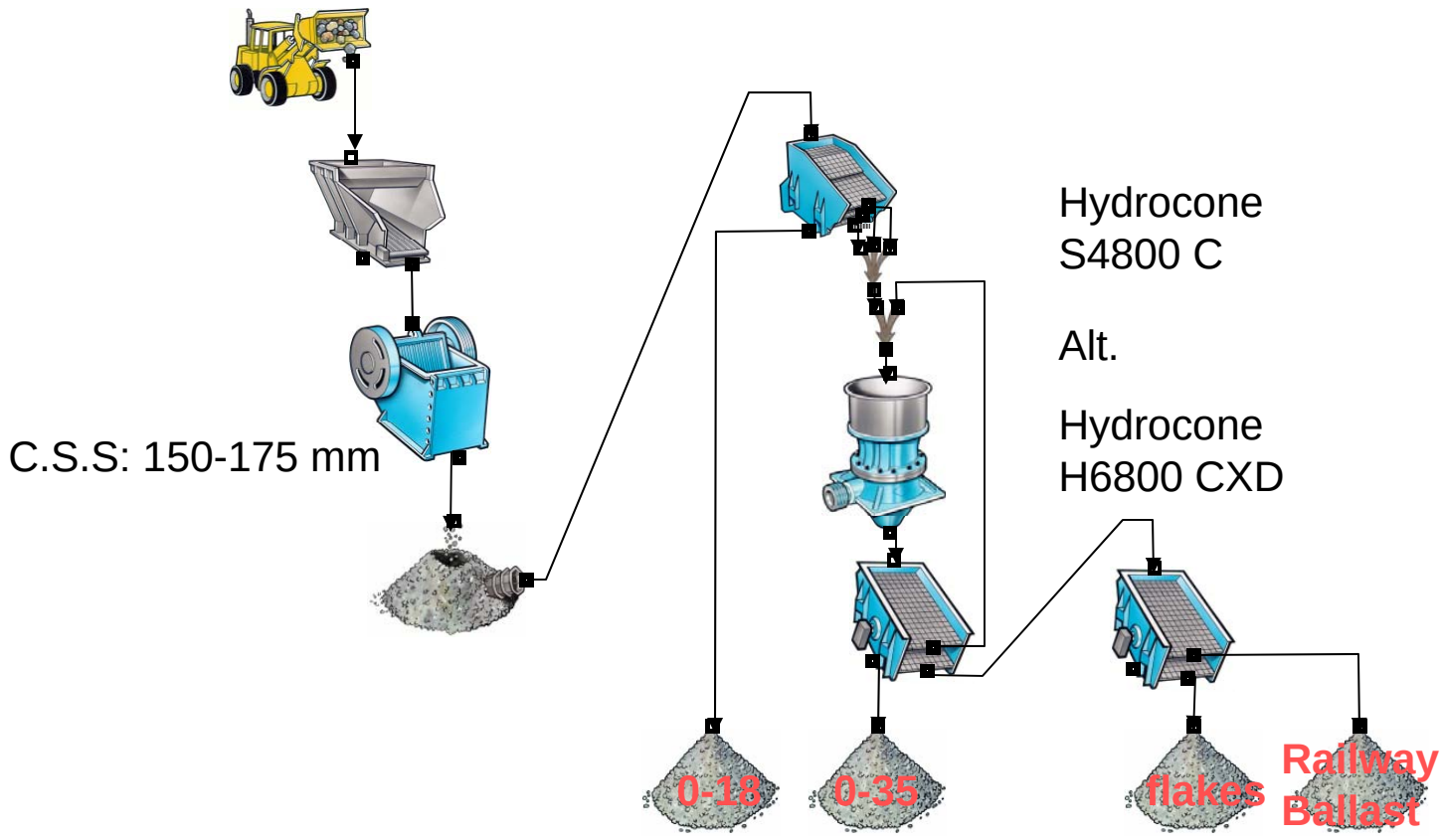
Secondary Crushers

Hydrocone H / S



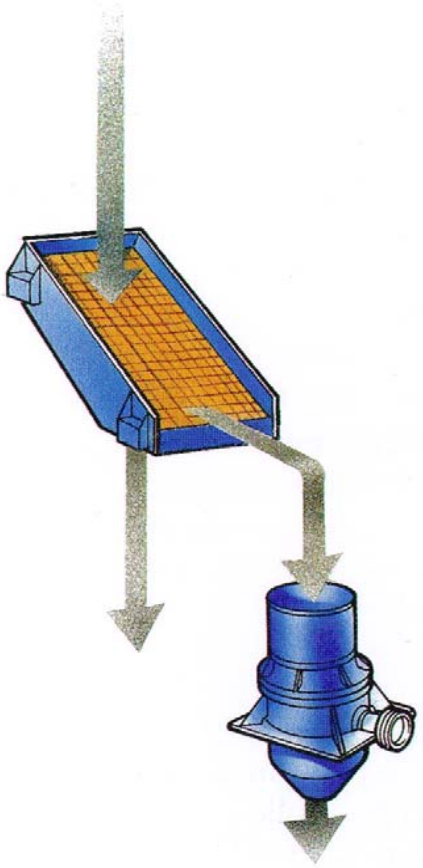
Secondary Impactor

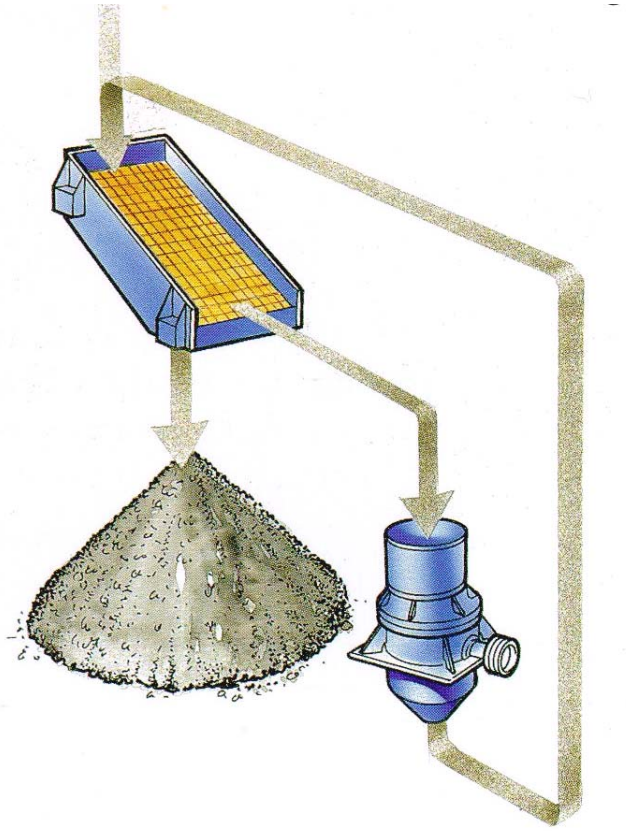
Production of railway ballast



Screening

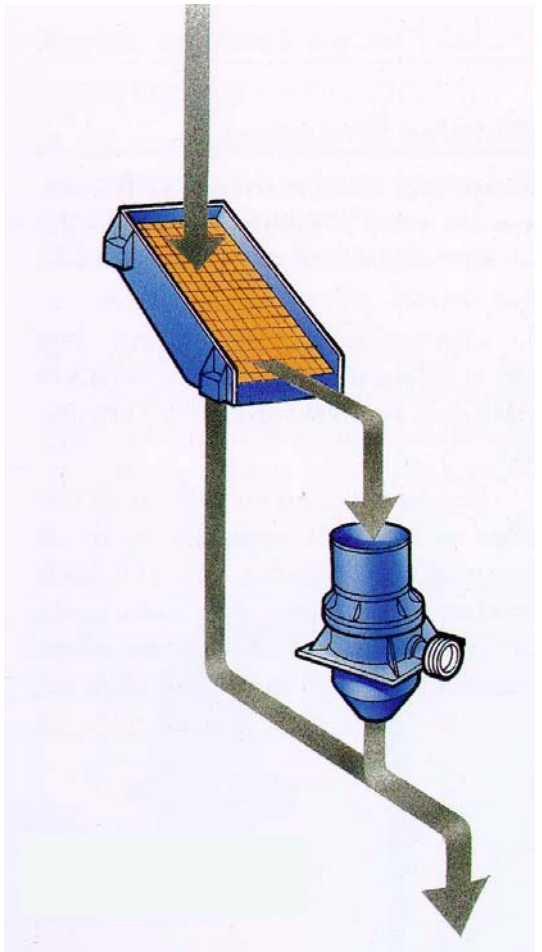
Open / Closed circuit





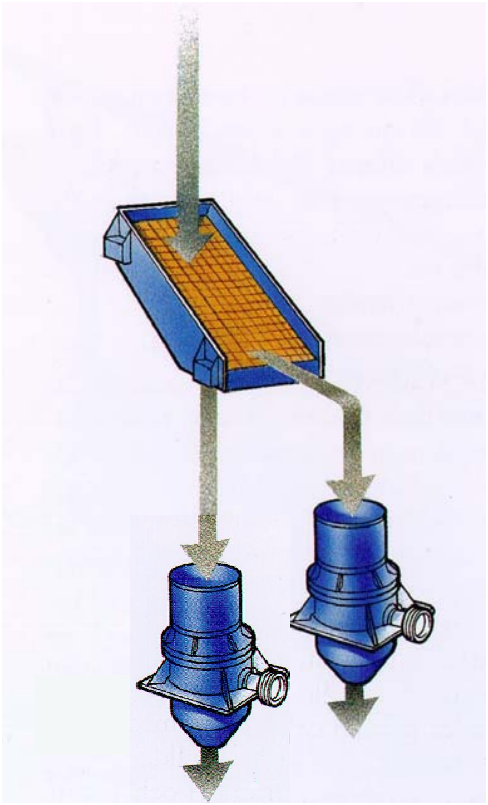
Open Circuit

- Screening ahead of a crusher avoids packing.
- Less wear in the crusher.
- Higher total capacity.
- The product is controlled by the screening cloth and the setting of the crusher.

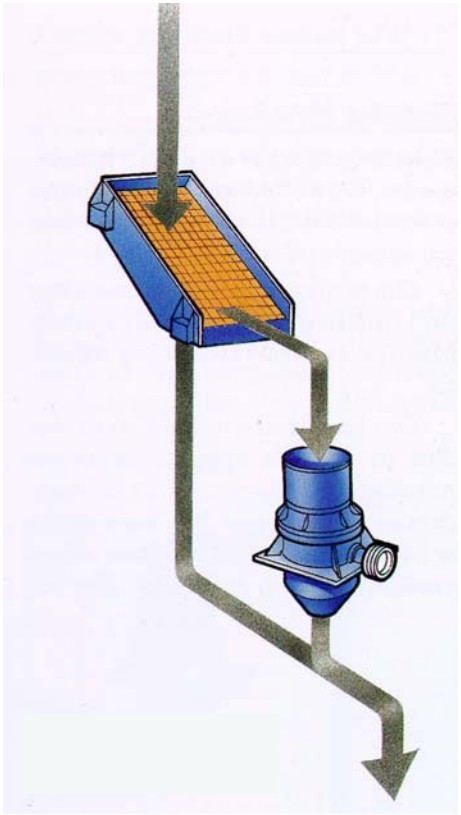


Open Circuit – Examples

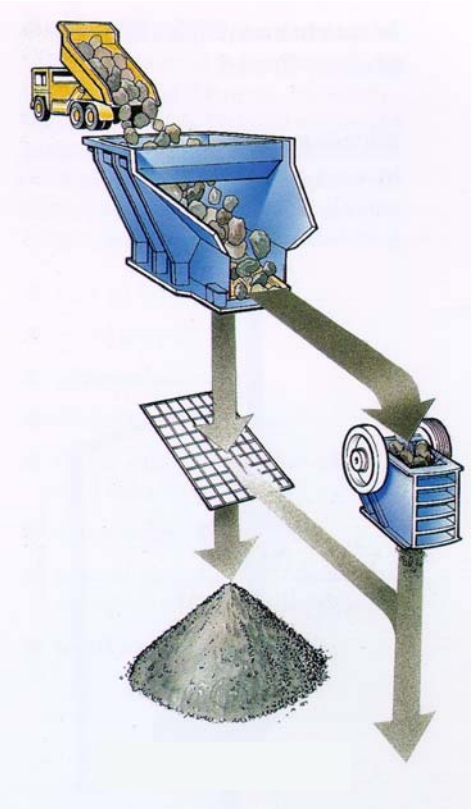
Splitting of crusher feed



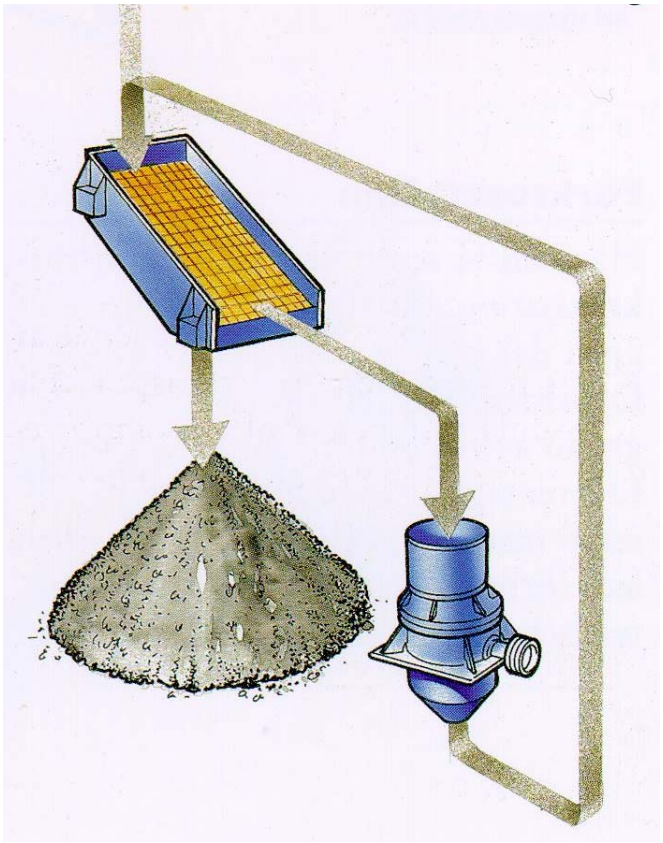
By-passing fine material



Scalping

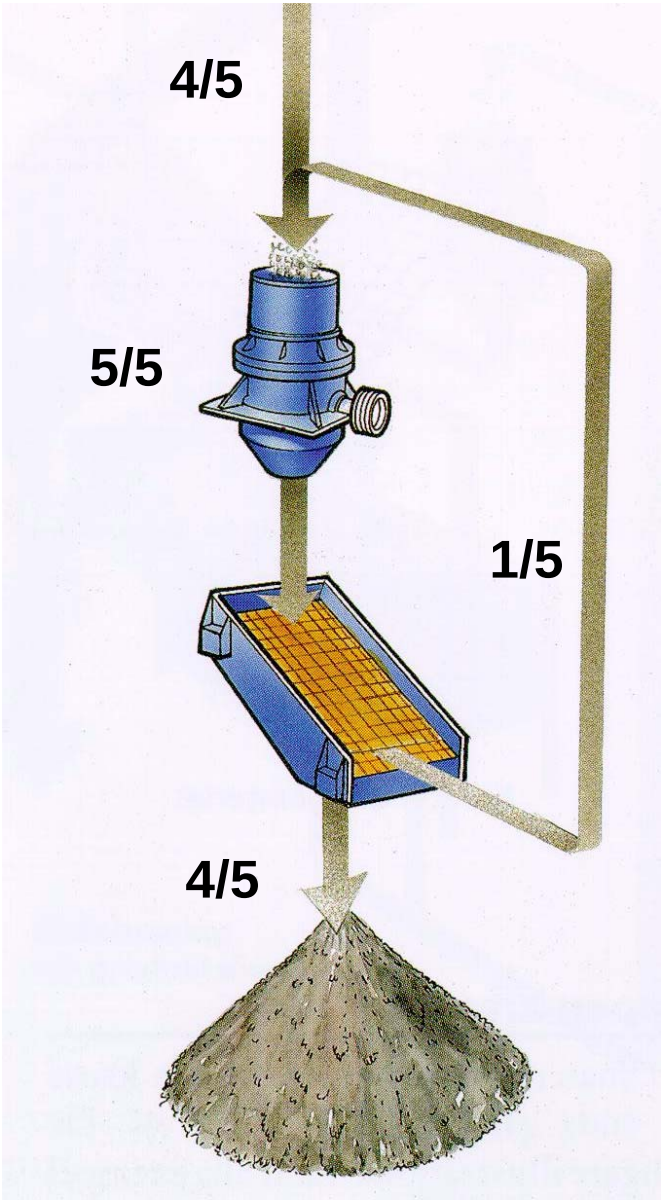


Closed Circuit



- Calibrated product
- Higher reduction ratio.
- Better cubical shape
- More machines
- Lower capacity

Closed Circuit

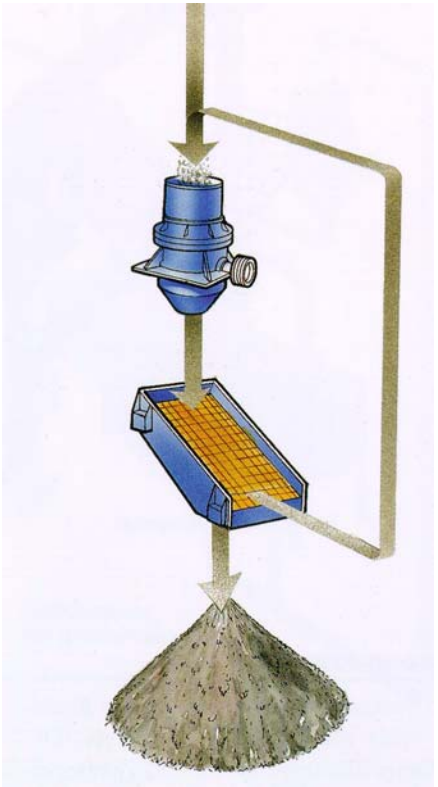


- Closed circuit ~ 1/5 of screen feed circulating recommended
- Smaller or same setting (CSS) as separation.
- Higher wear
- Cubical shape
- Big screen

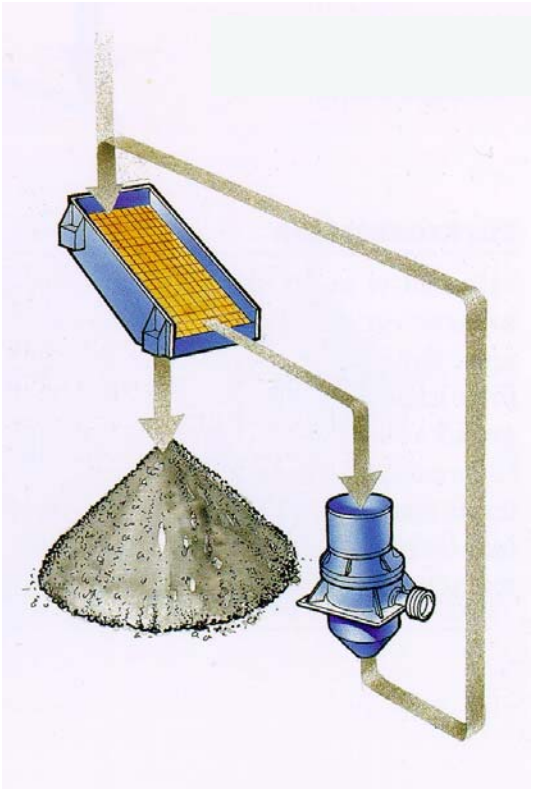
- discrepancy:
  - Short jobs
  - Prod of sand

Closed Circuit – Examples

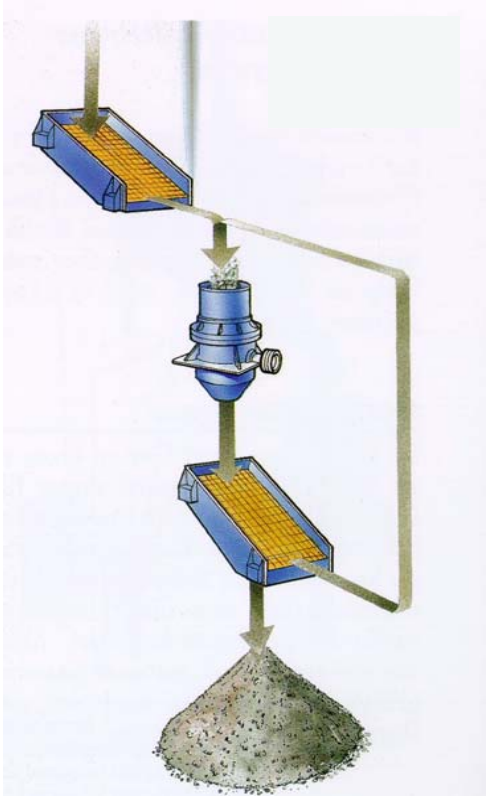
Screening after crusher



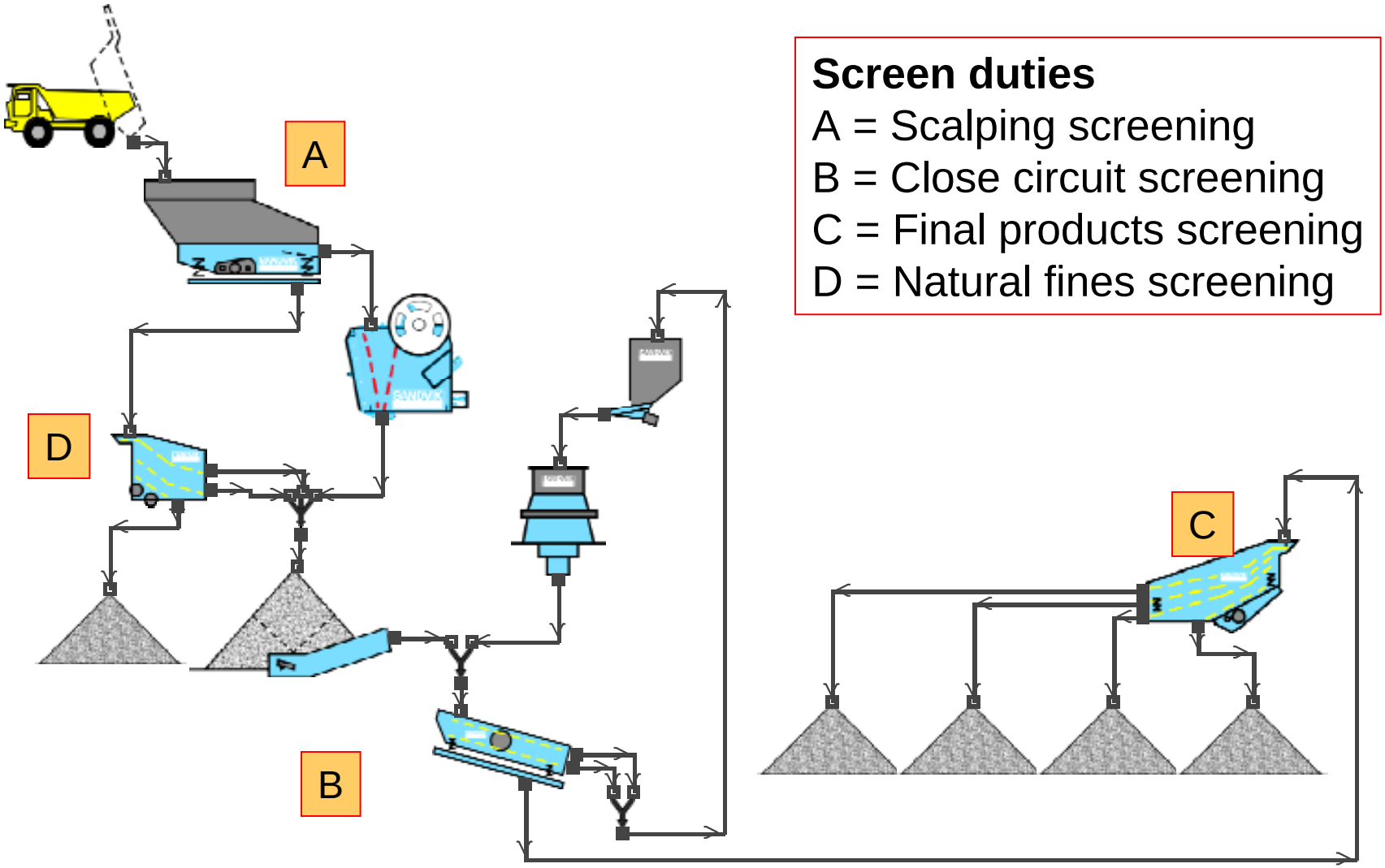
Screening ahead of crusher



Screening ahead of and after crusher



SCREENNING SUMMARY



Screen duties

A = Scalping screening

B = Close circuit screening

C = Final products screening

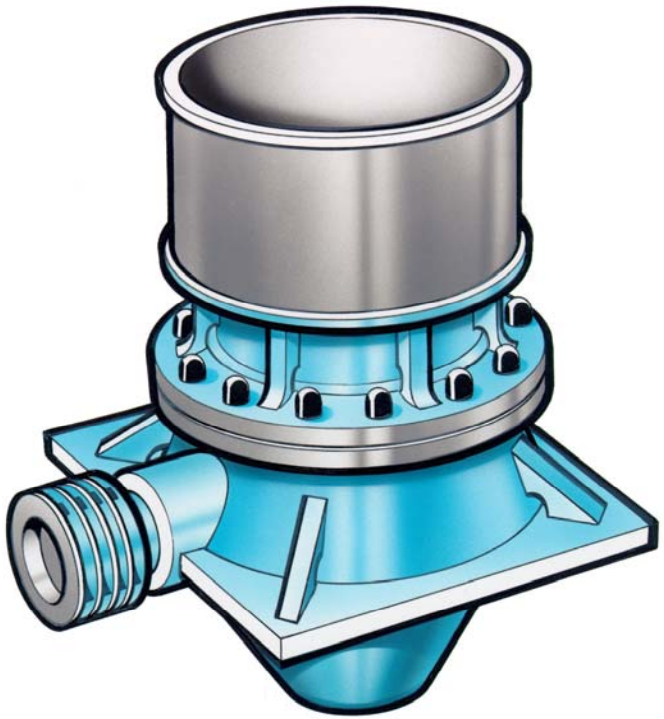
D = Natural fines screening

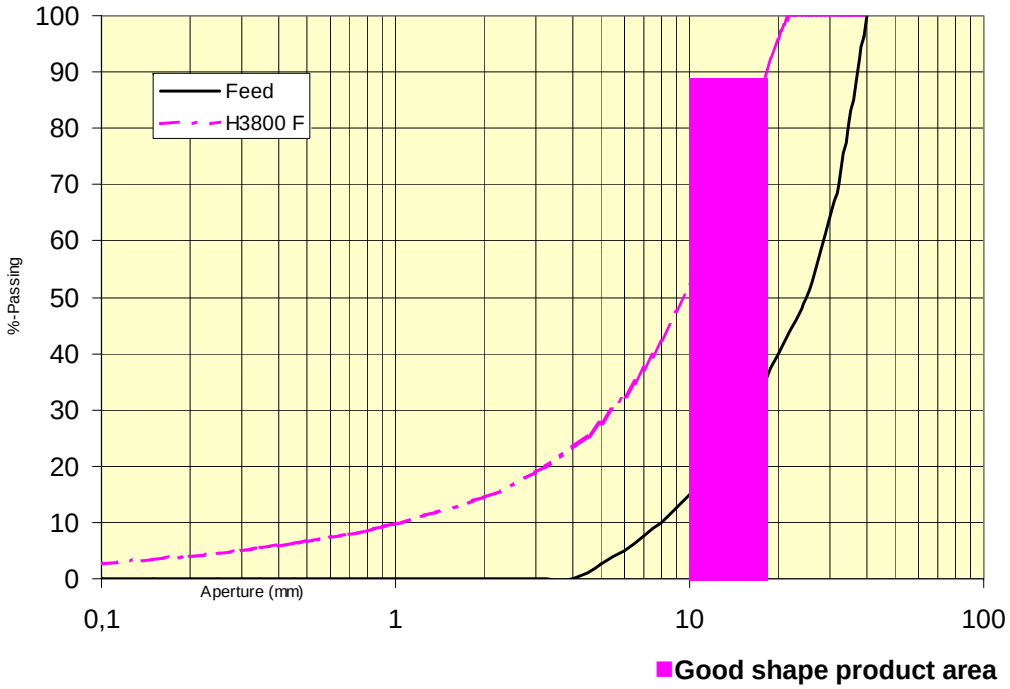
Final Crusher

Demands:

- Optimised feed
- Capacity
- Product shape

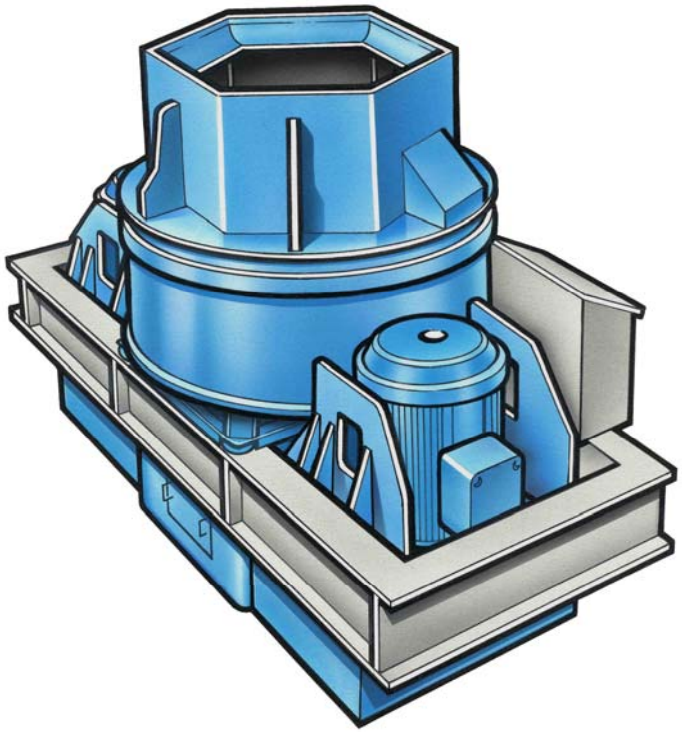
FINAL CRUSHER - Hydrocone

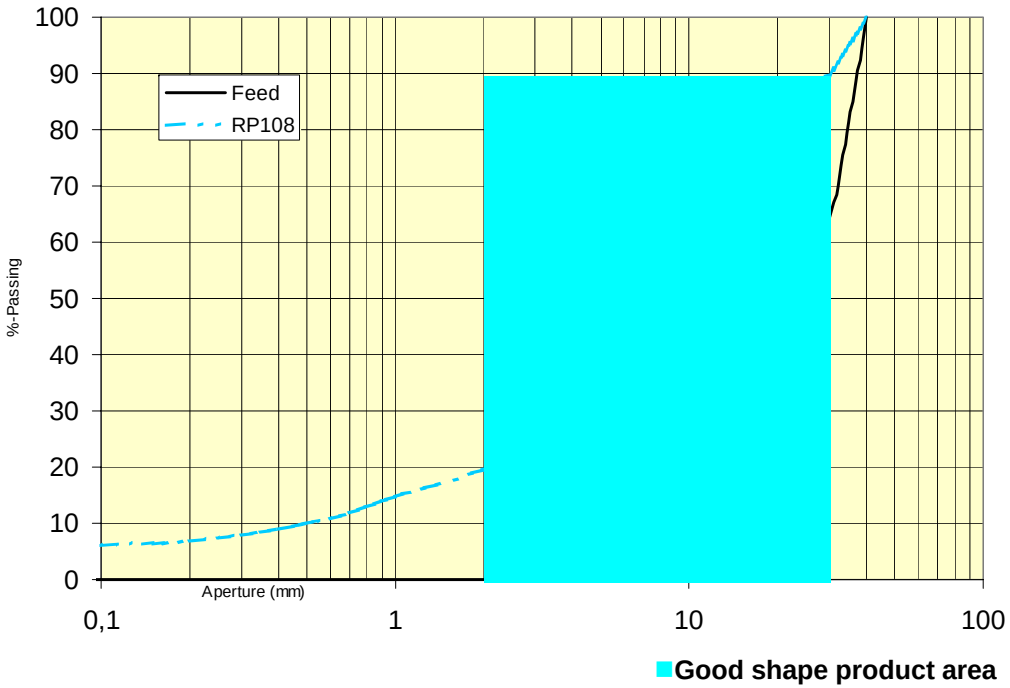




- Good Flexibility
- Higher crushing forces
- Limited good shape range
- Uniform reduction ratio

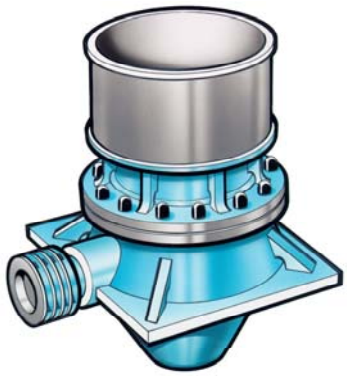
FINAL CRUSHER- Merlin VSI



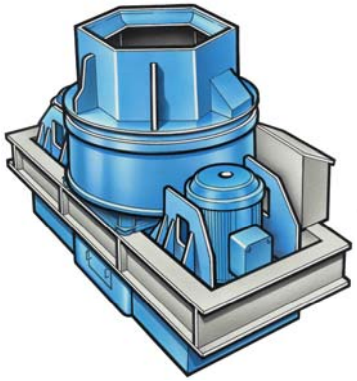


- Better shape
- Uneven Reduction
- Limited topsize capacity
- High fines production

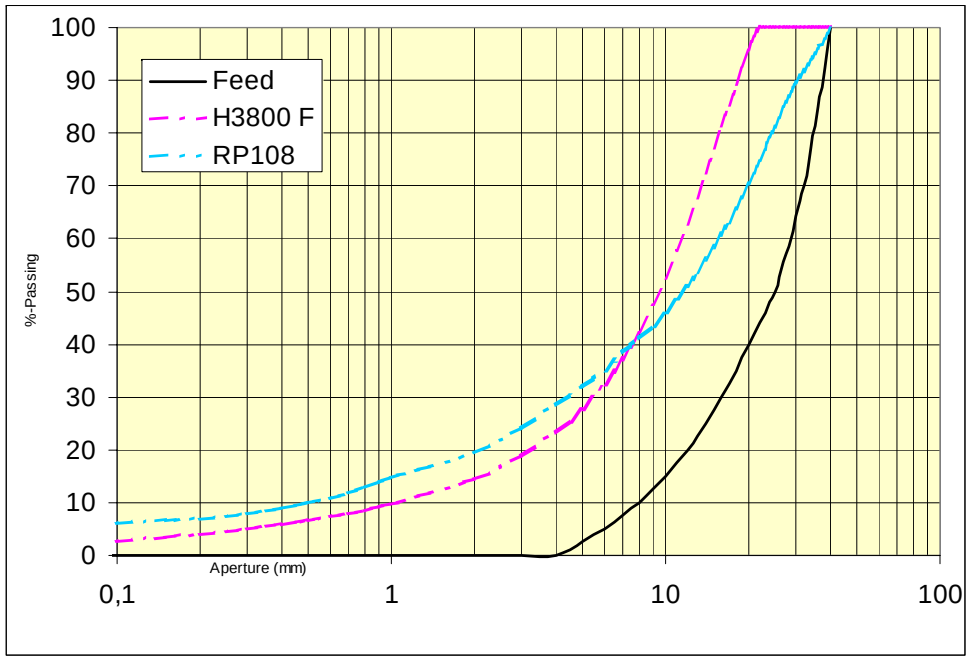
HYDROCONE – MERLIN RP



Hydrocone H3800 F
Ecc: 29 mm
C.S.S: 16 mm
ASR Plus

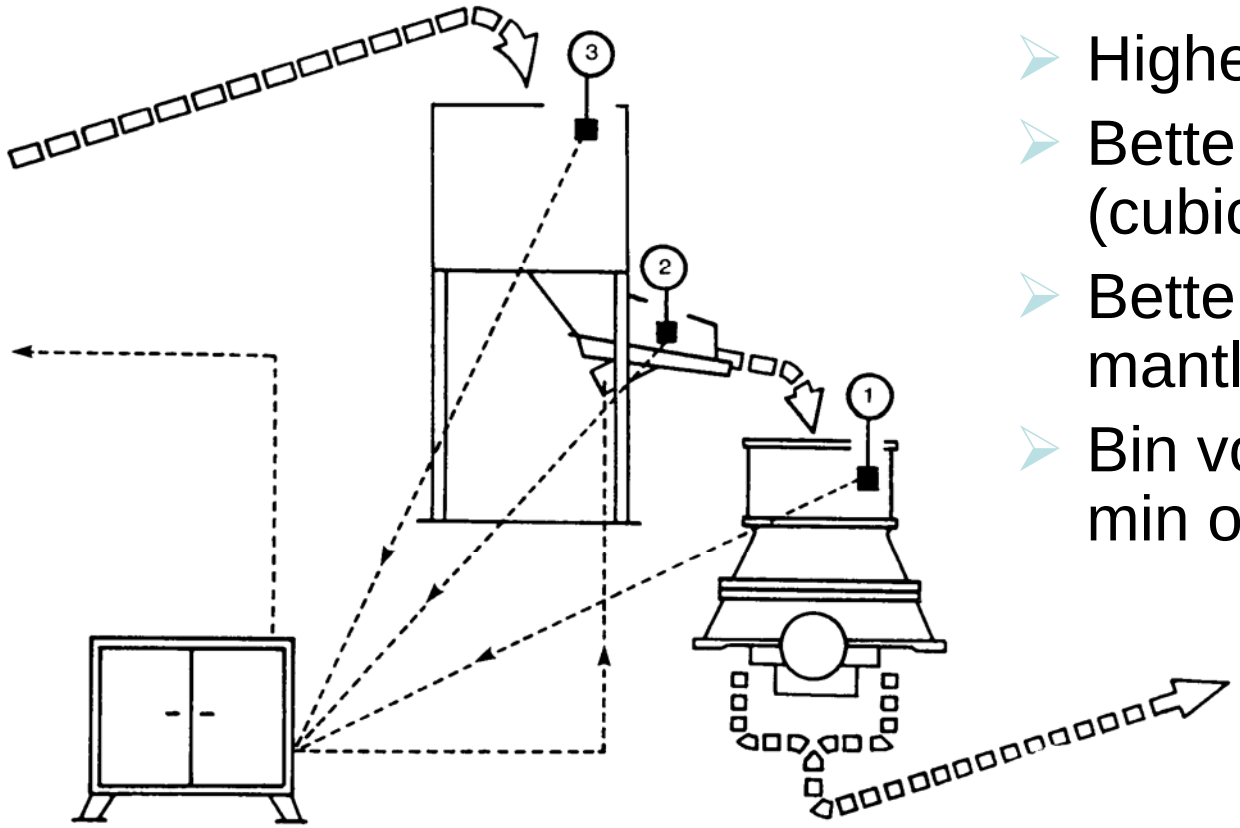


Merlin RP 107
Tip speed: 60 m/s
Bi-flow: 0 %
150 kW



Curves show Hydrocone H3800 F and Merlin RP 107 in a medium hard granite (Wi=16) in open circuit operation

Storage at Crusher

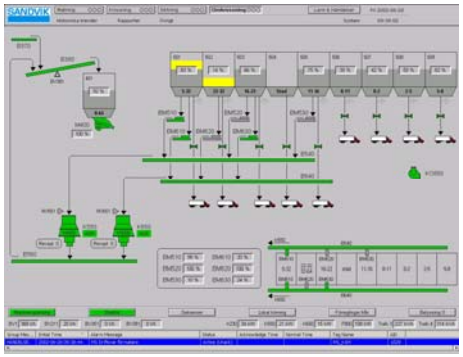


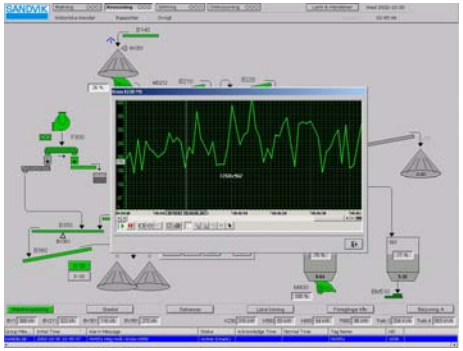
Choke fed Crusher;

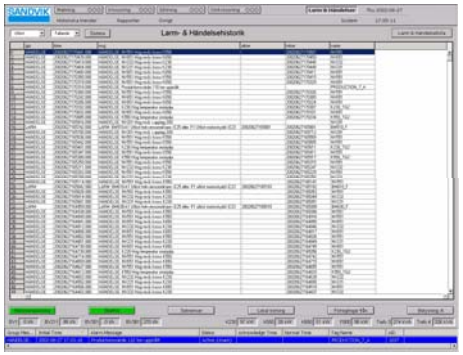
- Higher Reduction
- Better shape (cubical)
- Better utilization of mantle and liners
- Bin volume; 5-10 min operation

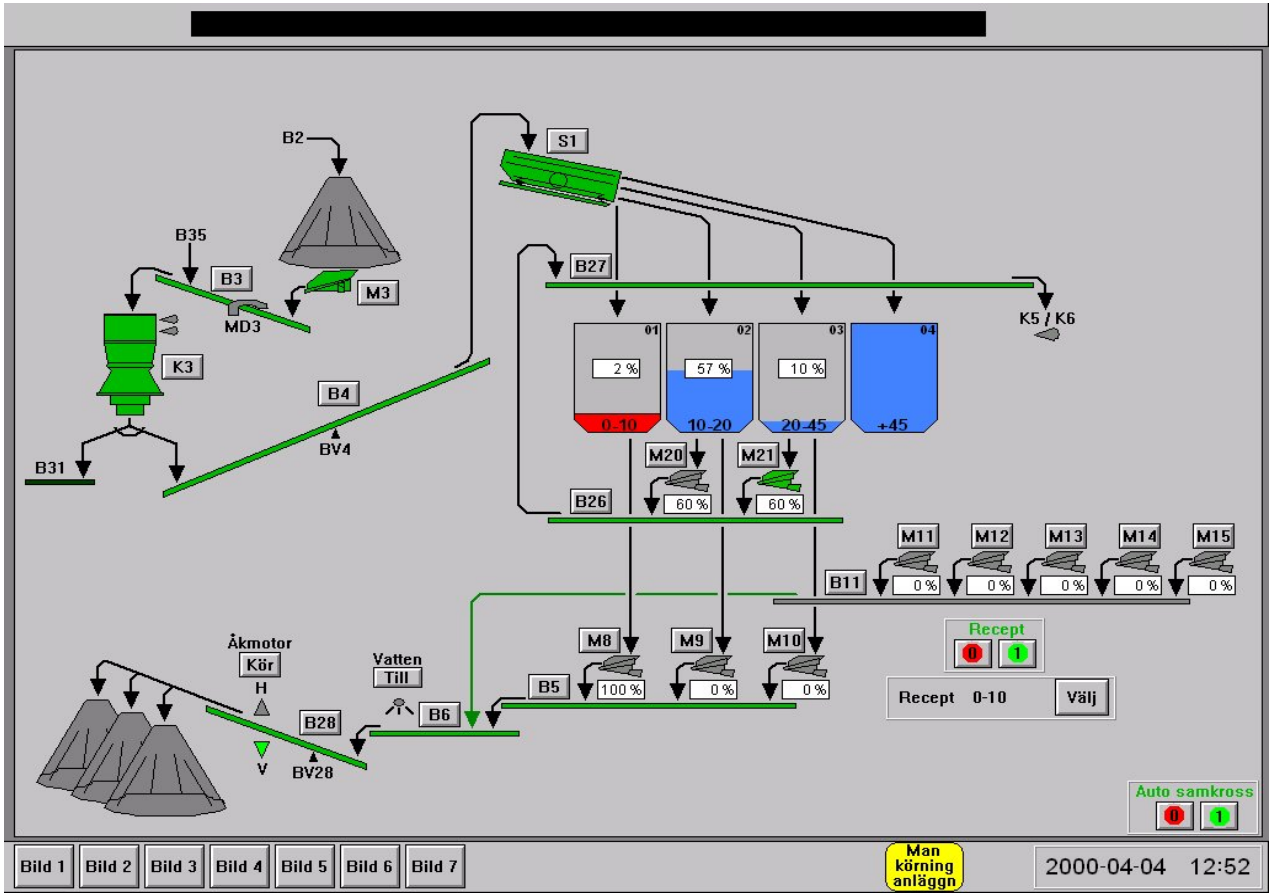
Crusher feed

Process Control









Stationary / Mobile

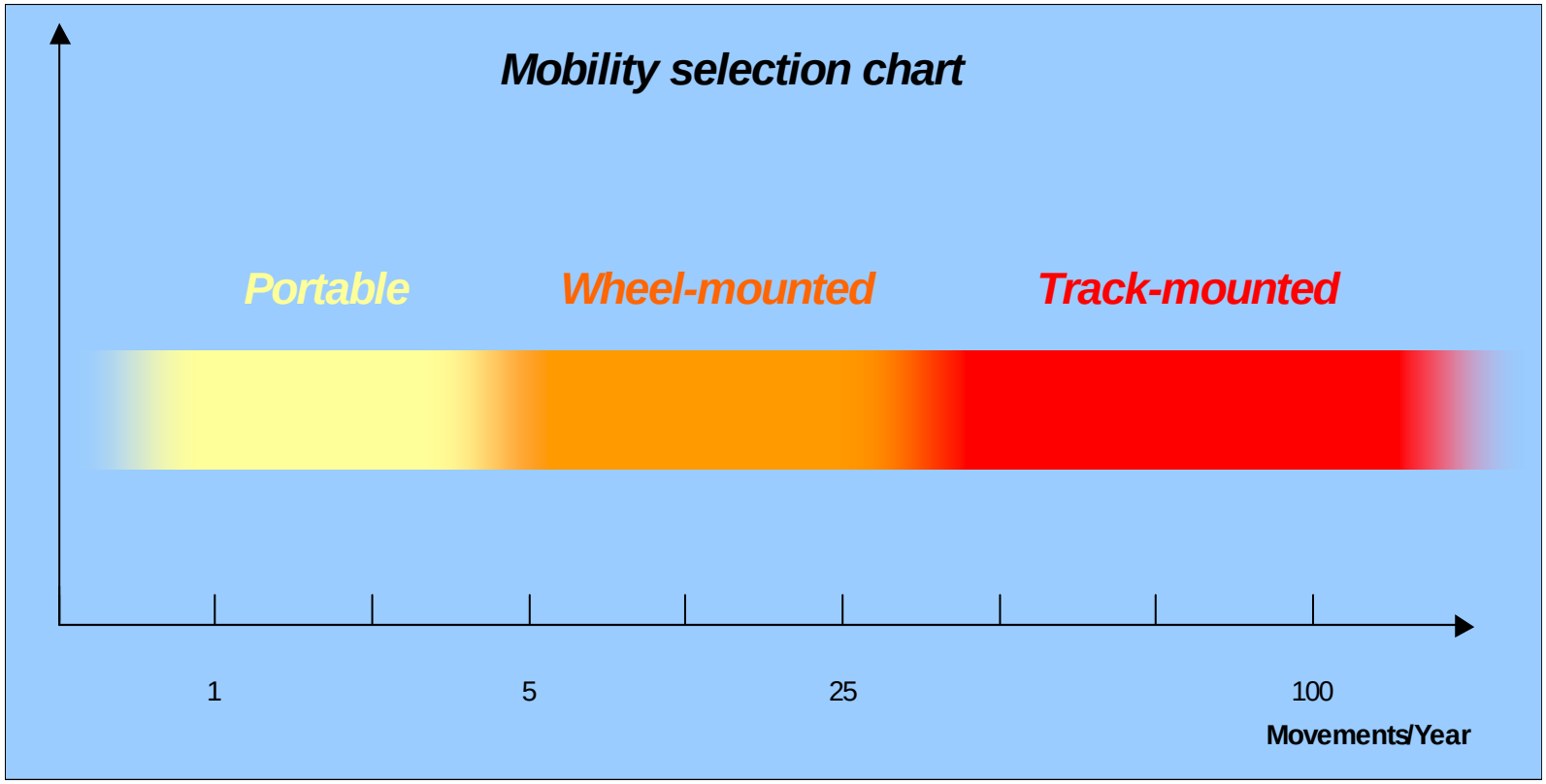
Stationary

- Long term Contracts
- Valuable products
- Range of products
- Production on demand
- Flexibility with many stages
- High Production control

Mobile

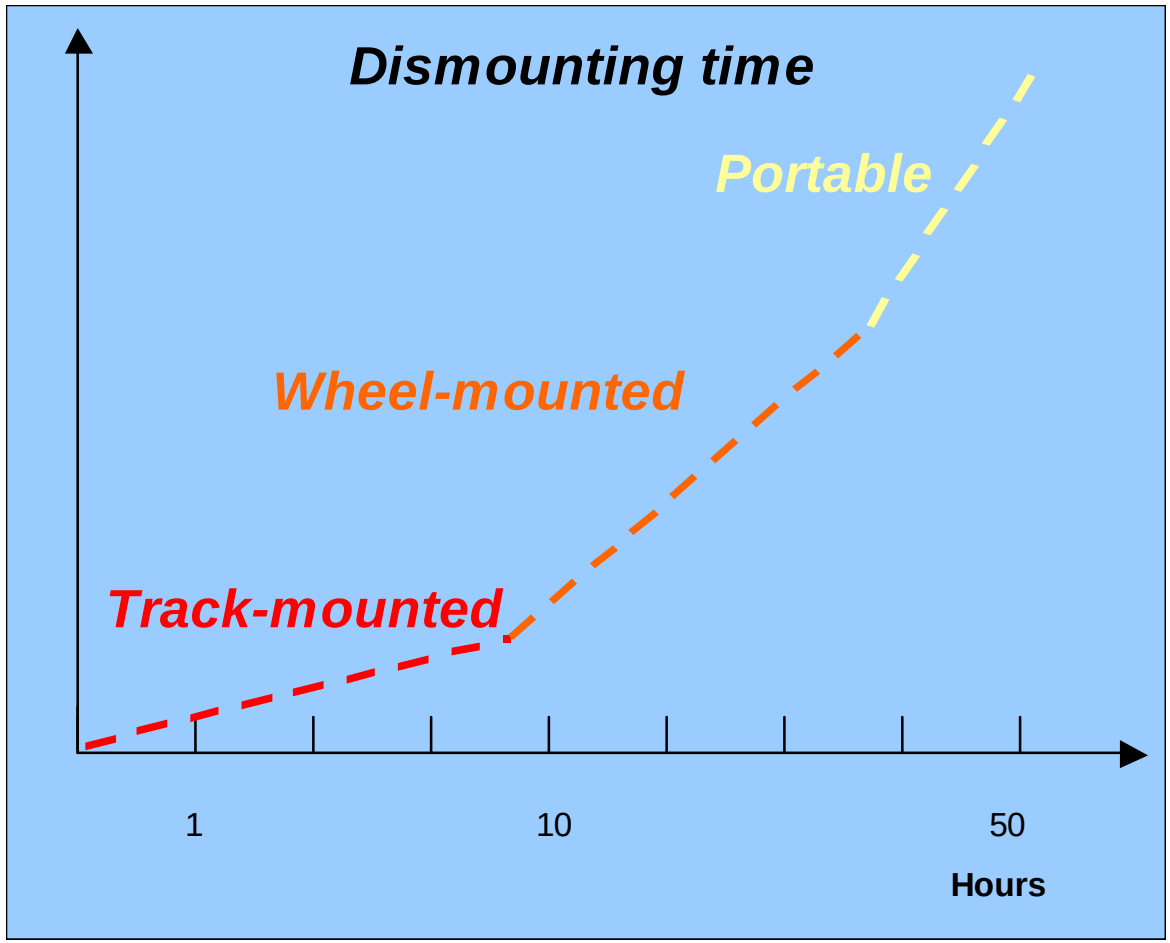
- Contract crushing
- Crushing at construction site
- Low product demands
- Few products
- Flexibility with Fleet

Mobile Units (1)

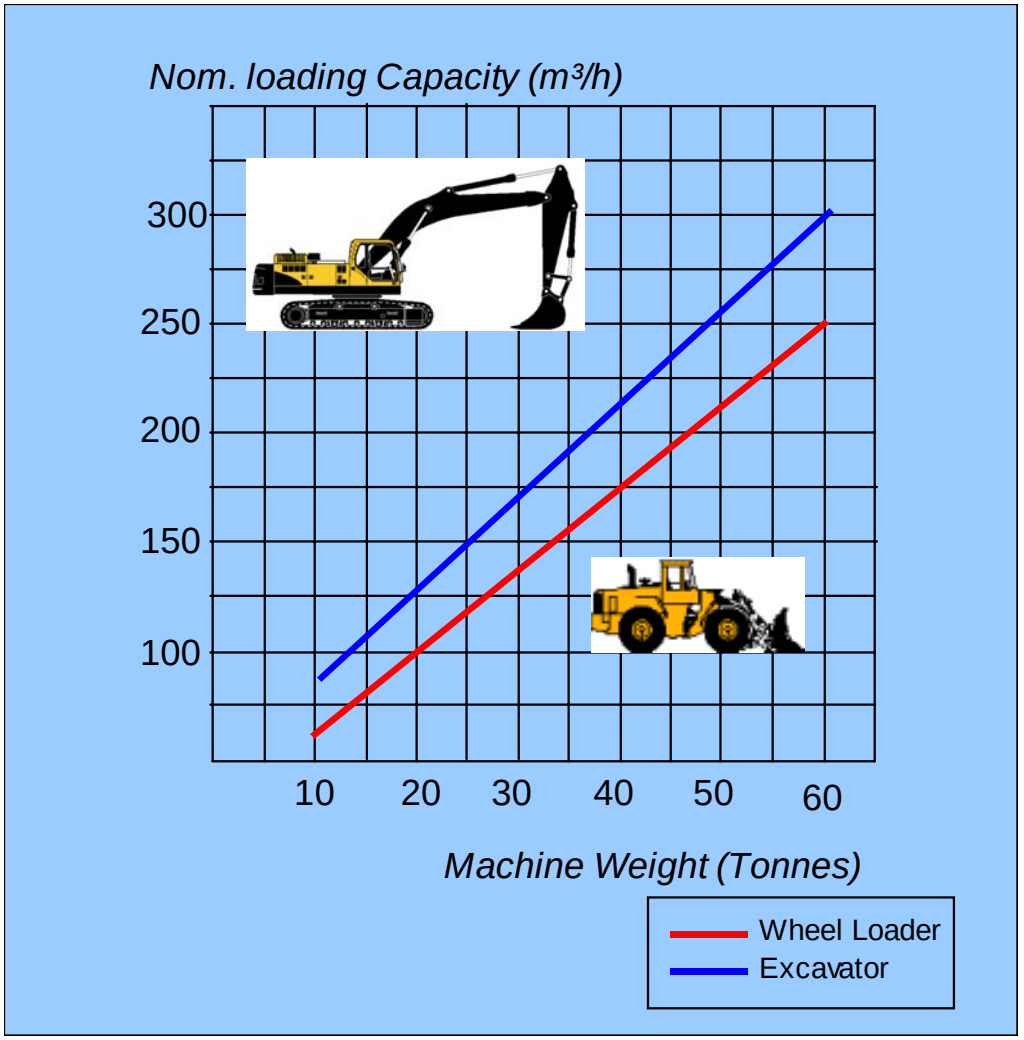


Mobile Units (2)

Mobile Units (3)



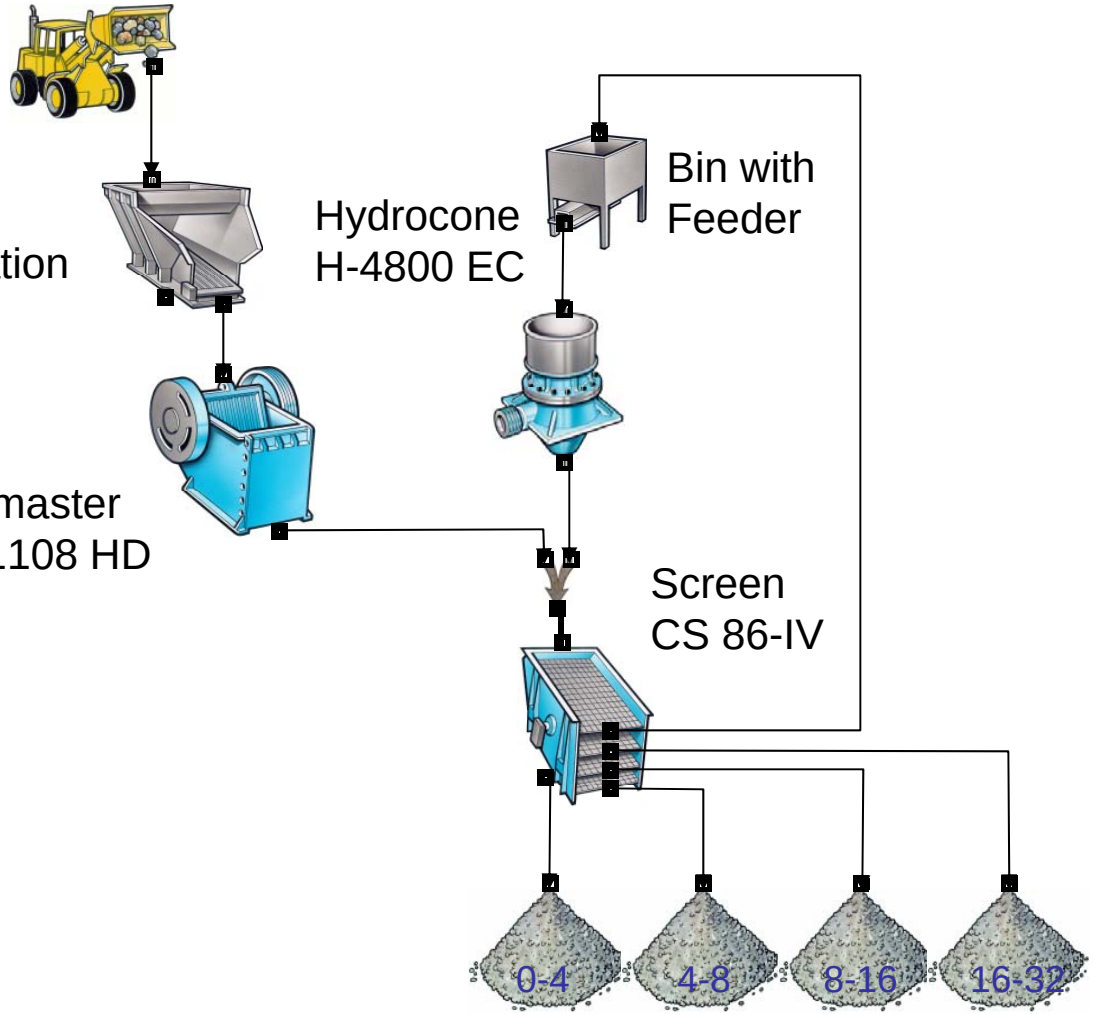
Mobile Units (4)



2-Stage Plant

Application Example

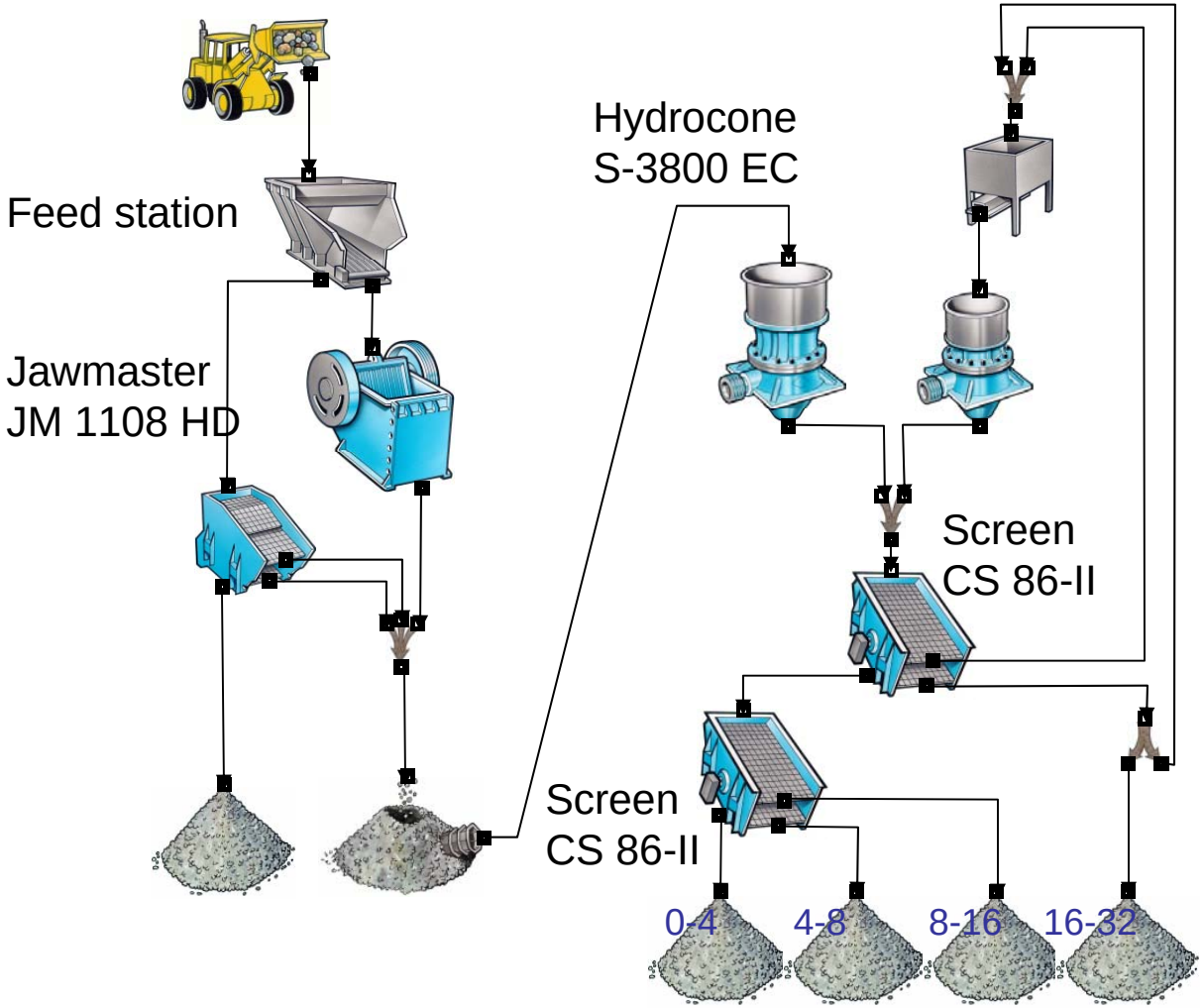
Capacity:200 tph



3-Stage Plant

Application Example

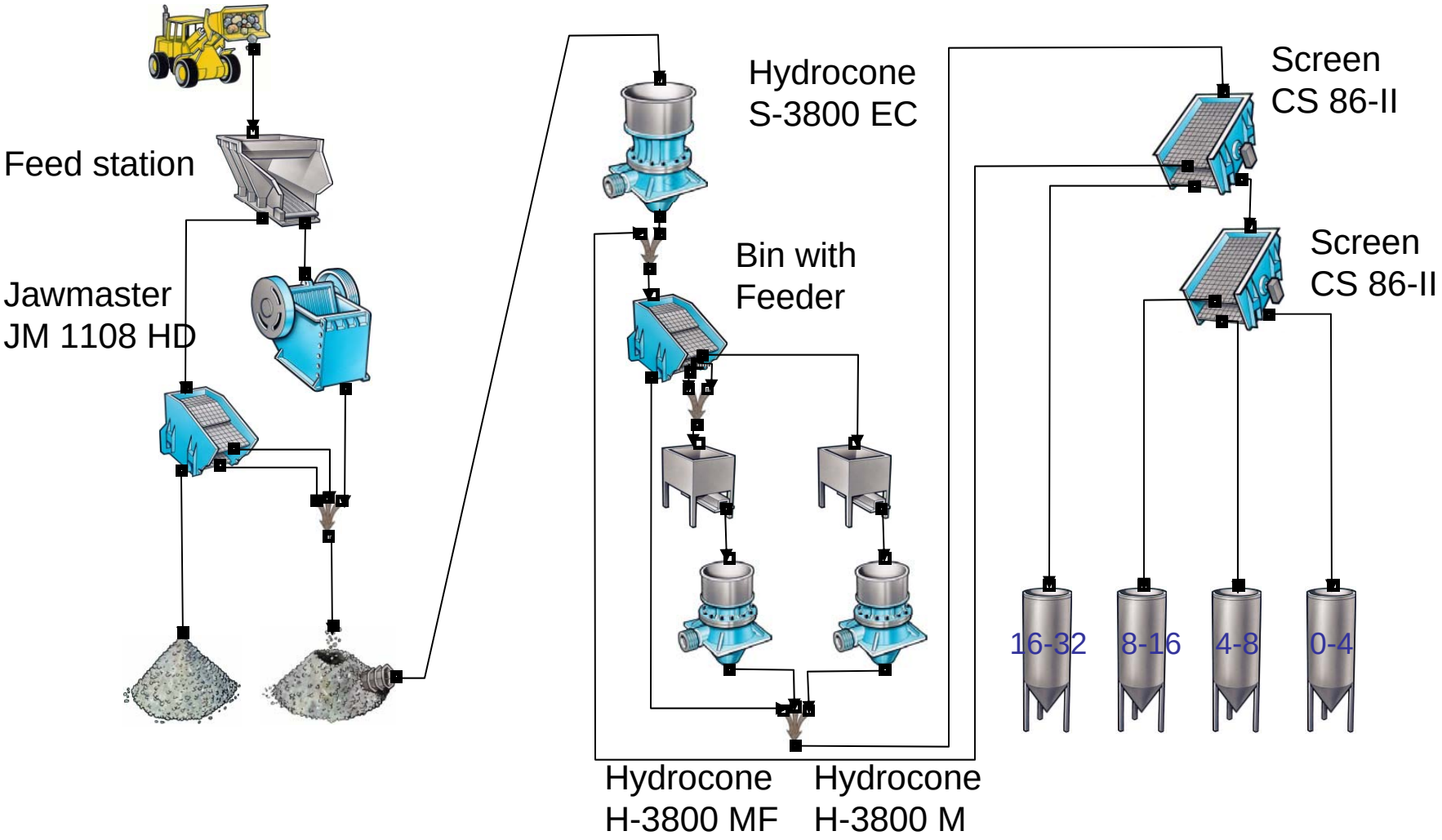
Capacity: 200 tph



4-Stage Plant, Cone

Application Example

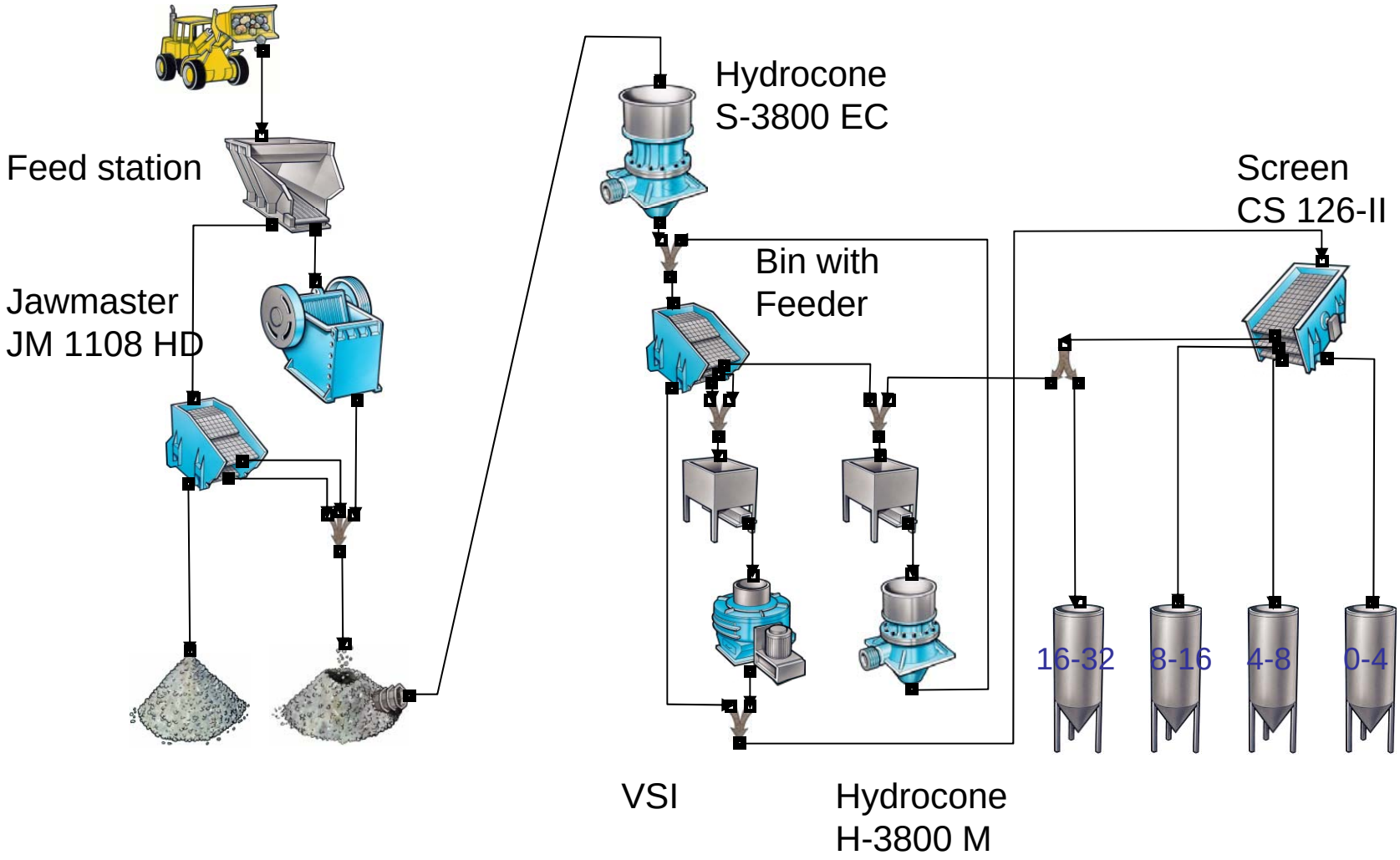
Capacity: 200 tph



4-Stage Plant, VSI

Application Example

Capacity: 200 tph



Application examples

SUMMARY

Product distribution

Product	0-4 mm	4-8 mm	8-16 mm	16-32 mm
2-stage	33 t/h	19 t/h	41 t/h	107 t/h (*)
3-stage	43 t/h	29 t/h	66 t/h (*)	62 t/h *
4-stage	61 t/h	35 t/h *	54 t/h *	50 t/h *
4-stage, VSI	88 t/h	38 t/h *	44 t/h *	30 t/h *

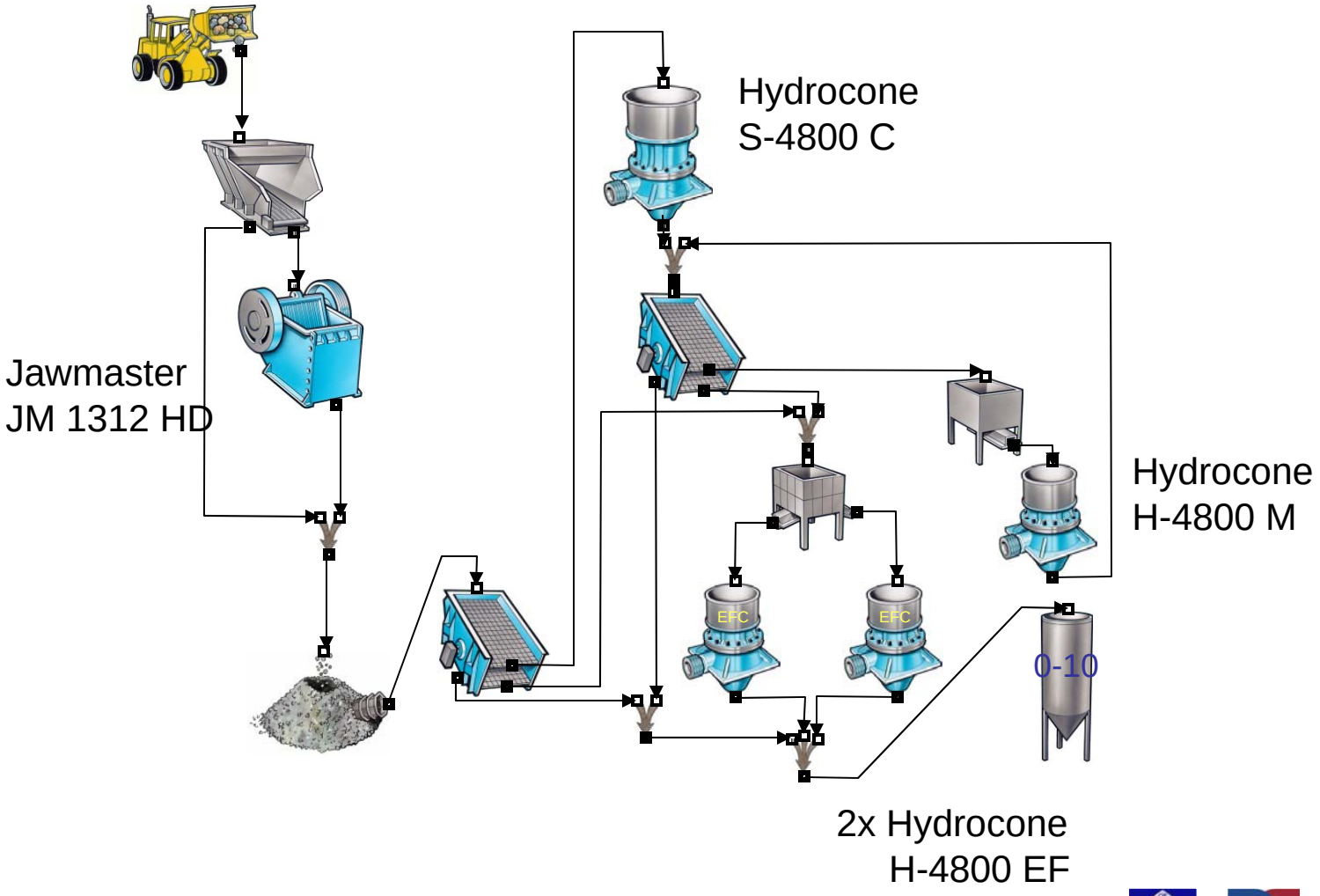
* Good shape

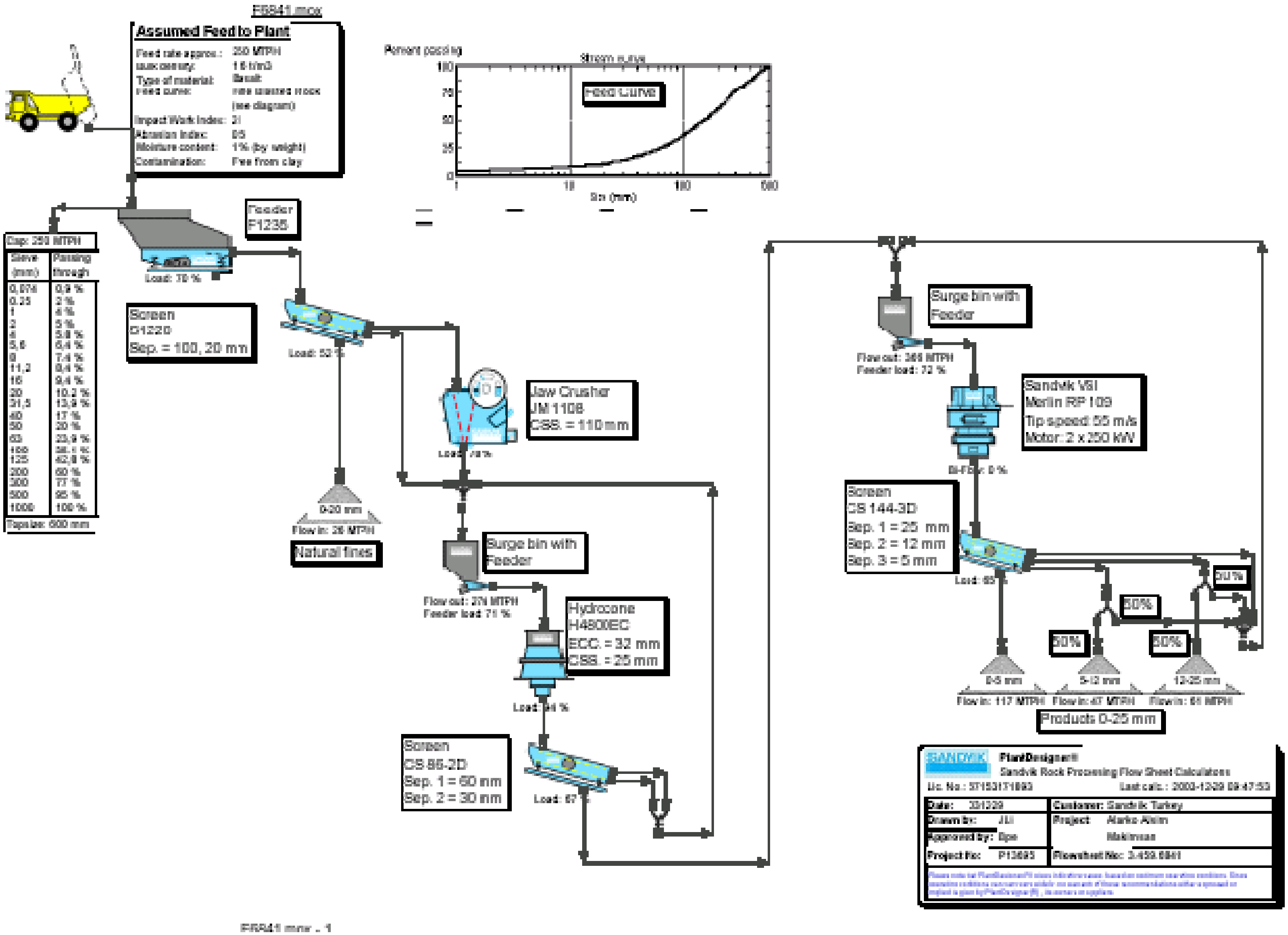
2-stage
Cheap
Easy to move
Bad shape
Low flexibility

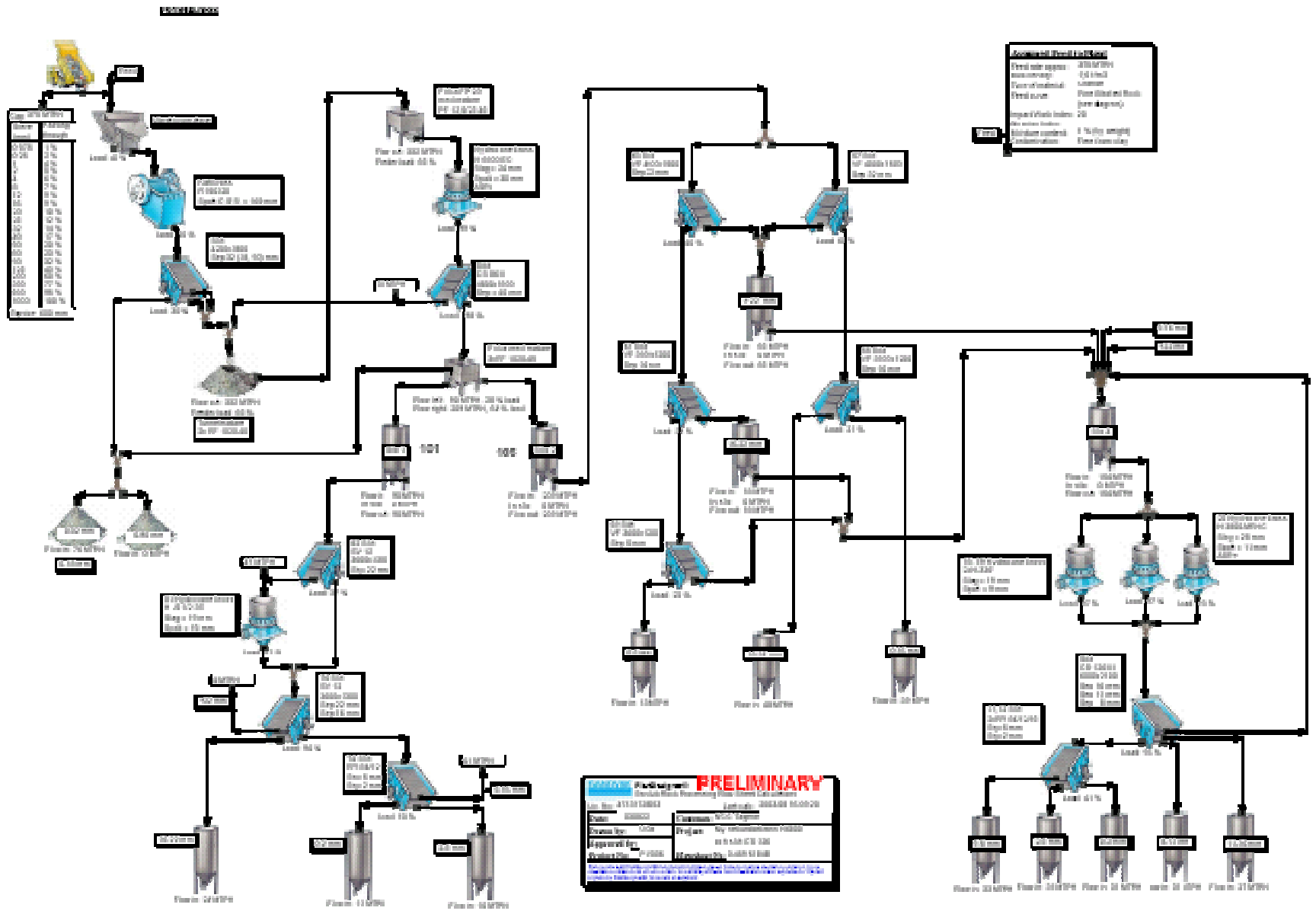
3-stage
Medium expensive
Could be moved
Medium shape
Good flexibility

4-stage
Expensive
Difficult to move
Very good shape
Very good flexibility

Mining Plant




Assumed Feed to Plant
Feeder F1235
Load: 70 %
Screen
Sep. = 100, 20 mm
Natural fines
Feed Curve
Jaw Crusher
JM 1108
CSS. = 110 mm
Surge bin with Feeder
Hydrocone
H4800EC
ECC. = 32 mm
CSS. = 25 mm
Screen
CS 86-2D
Sep. 1 = 60 mm
Sep. 2 = 30 mm
Surge bin with Feeder
Sandvik VSI
Merlin RP 109
Tip speed 55 m/s
Motor: 2 x 250 kW
Screen
CS 144-3D
Sep. 1 = 25 mm
Sep. 2 = 12 mm
Sep. 3 = 5 mm
50%
50%
50%
50%
Products 0-25 mm
PlantDesigner®
Sandvik Rock Processing Flow Sheet Calculations
Customer: Sandvik Turkey


PRELIMINARY