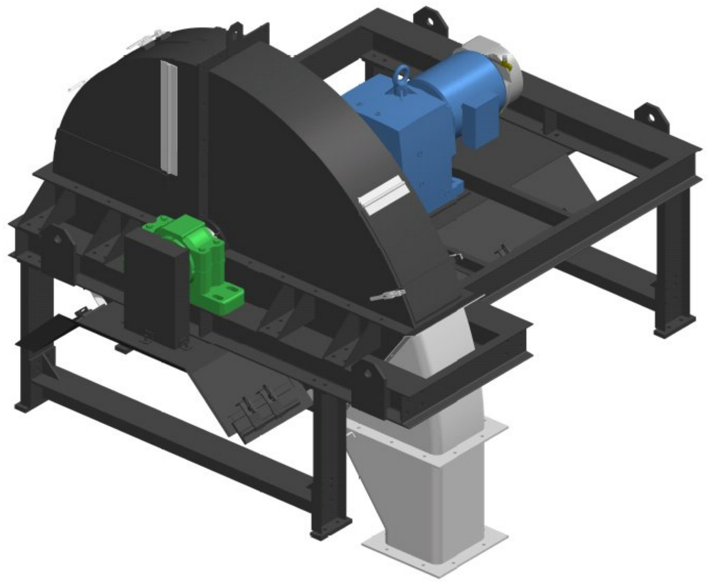
SGS MECHANICAL SAMPLING SYSTEMS

SGS SAMPLING HISTORY

- SGS has manufactured and supplied mechanical sampling equipment (MSS) primarily in Australia, Asia, and Europe for over 20 years. SGS cross-belt samplers are re-engineered and the design significantly updated and improved supply superior, yet cost effective systems.

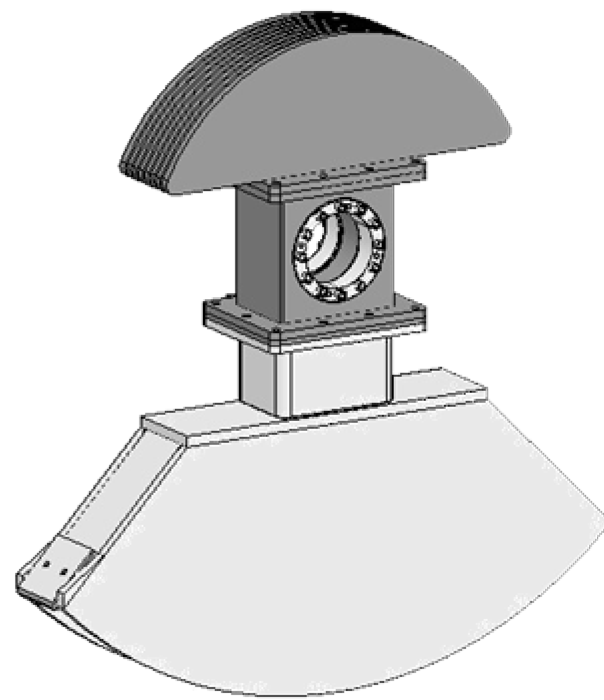


CROSS BELT SAMPLER DESIGN FEATURES

- Available to fit any size, speed or capacity belt, metric or imperial
- Large range of top sizes can be accommodated
- Heavy duty cutter and enclosure construction
- Detailed engineering of mechanical components
- Direct drive
- Fluid shear brake
- Adjustable skirt-boards
- Non-stick spiral enclosure
- Closed loop speed and position control available
- Hydraulic drive options available

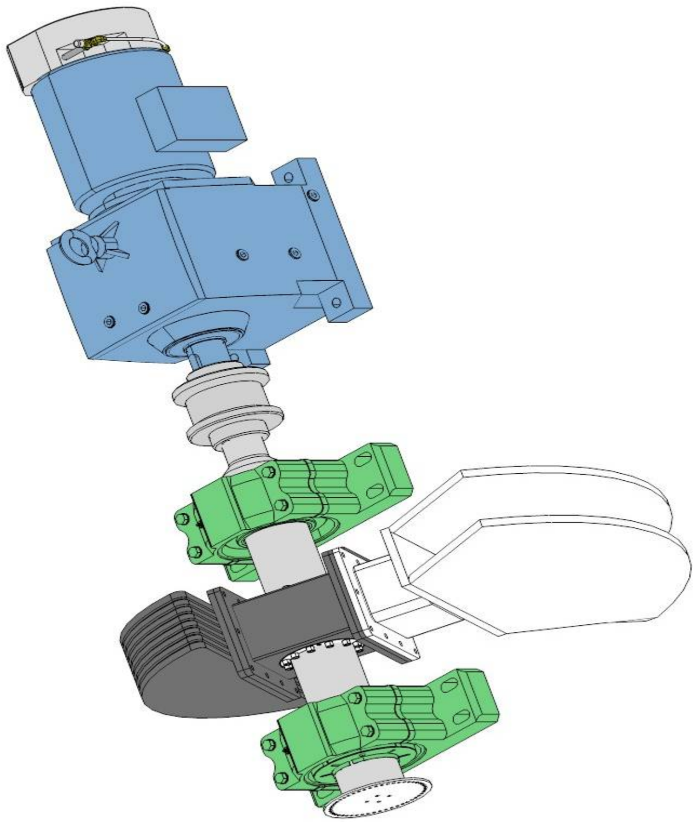
HEAVY DUTY CUTTER

- Ultra heavy duty components for long life
- Engineered to minimize weight without compromising sample integrity
- Engineered to accommodate worst case loading
- Conservative safety factors
- Standard stainless steel cutter body
- Counterweighted for balance and increased inertia
- Counterweight eliminates the forces on the customer's structure resulting from an eccentric cutter load if no counter weight is used
- Belt wiper ensures complete increment collection



CAREFULLY SIZED COMPONENTS

- Drive components custom selected for each application
- All components selected for durability
- Components are oversized to handle the harshest conditions
- Shock loading and fatigue are primary design considerations



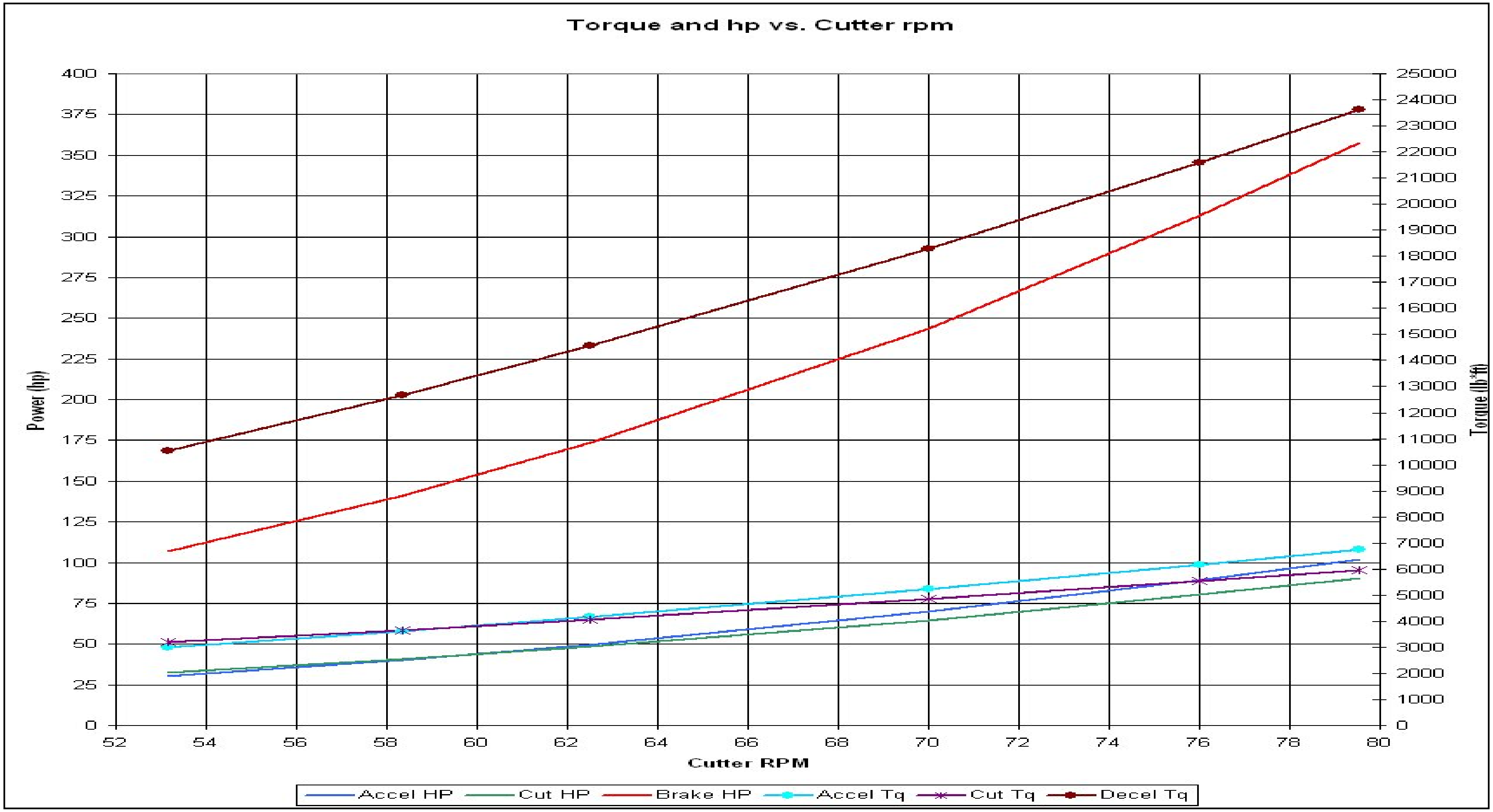
DYNAMIC ANALYSIS

	A	B	C
1	Generic 48in Primary		8/17/2009
2			
3	English/Imperial Units		
4			=Calculated cells
5		Number	=Input cells
6			
7	Belt and Material Data	Inputs	
8			
9	Belt Width (b)	48	in
10	Belt Capacity	2574	t/hr
11	Belt Speed	800	ft/m
12	Angle Of Idler (β)	35	degrees
13	Roller Width plus air gap between rollers (l)	17.5	in
14	Conveyor Incline Angle	0	degrees
15	(if positive material is ascending)		
16			
17	Bulk Material Characteristics		
18	Surcharge Angle (α)	25	degrees
19	Nominal Top Size	2	in
20	ASTM Factor	1.5	:1
21			
22	Construction Materials		
23	Cutter		
24	Cutter Side Material Thickness	0.75	in
25	Steel Density (304 SS)	0.289	lb/in^3
26			
27	Other Parts (hub, counterweight, spacer)		
28	Thickness	0.5	in
29	Density (304 SS)	0.289	lb/in^3
30			
31	Motion Characteristics		
32	Angle to accelerate cutter to full speed	67.000	degrees
33	Stopping angle	40.000	degrees
34	Overlap between sample cut and decel	0.000	degrees
35	Angle over which sample is cut	89.349	degrees
36	Steady State Angle (pre cut)	163.651	degrees
37	Gear Reduction ratio	20.620	to 1
38	Drive RPM from Motor	1765.000	RPM
39			
40	Component Friction Coefficients		
41	Friction Coefficient coal against the cutter	1.000	
42	Friction Coefficient coal sliding on the belt	0.500	
43	Wiper Friction	5.000	lbs/in of wiper
44			
45			
46	Shaft Physical Parameters		
47	Bearing Width	1.000	in
48	Driven Stub Shaft	3.000	in
49	Driving Stub Shaft	10.000	in
50	Material Density	0.289	lb/in^3
51	σu	73200	psi
52	σy	31200	psi
53	E (Modulus of Elasticity)	28,500,000	
54	Torsional Modulus G	11,500,000	
55	Permissible axial deflection	0.0015	radians
56	Maximum torsional deflection	0.08	degrees/ft of shaft
57	Shaft from motor to cutter		

	E	F	G
7	Geometric Results		
9	Cutter Radius (r..)	27.751	in
10	Cutter Angle (α..)	89.3	deg
11	Clearance Radius (r..)	10.789	in
12	Cutter Inside Width (w..)	6	in
13	Cutter Outside Width (w..	13	in
14	Overall Shaft Length	27.418	in
15	Shaft Dia	4	in
18	Total Rotational Mass		
19	Cutter Rotating Mass	902.19	lb
20	Motor Rotor Mass	0.25	lb
21	Coupling Rotating Mass	1.00	lb
22	Shaft Mass	99.58	lb
23	Total=	903.44	lb
26	Inertia		
27	Cutter	1149.618	lb*ft^2
28	Motor (rotor and geartrain)	0.500	lb*ft^2
29	Brake	0.061	lb*ft^2
30	Coupling	0.050	lb*ft^2
31	Shaft	1.383	lb*ft^2
32	Total Rotational Inertia	1151.612	lb*ft^2
33	Cutter Rotating Mass	902.19	lb
36	Bearing Reaction Forces		
37	R..=	0.00	lbf
38	R..=	841.40	lbf
40	R..=	-1433.05	lbf
41	R..=	-1743.59	lbf

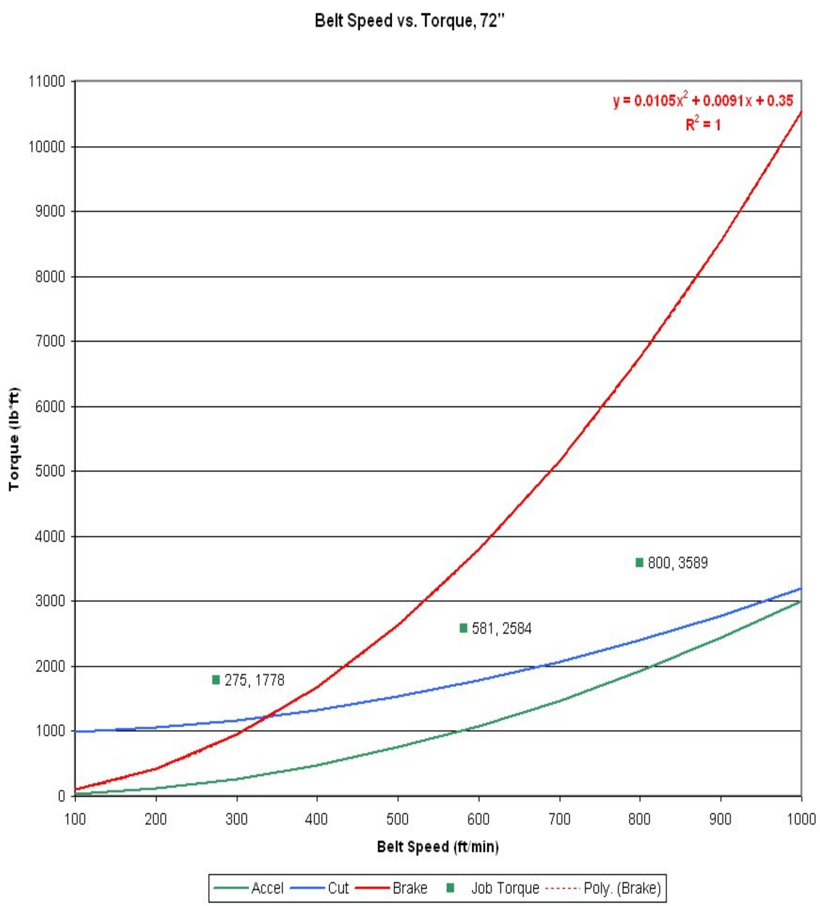
	I	J	K	L	M	N	O
7	Motion, Torque, and Power						
9	Total Cycle Time (estimated)	0.591	s				
10	Minimum Tip Speed of Cutter (min 1.5x of belt speed)	1200.000	ft/min				
11	Actual Max Tip Speed of Cutter	1243.771	ft/min	green=ok, red=check gear ratio			
12	Full Speed RPM of cutter (gearbox output)	85.597	RPM				
13	Full Speed Angular Velocity	8.964	radians/s	ω=2π*rev/min			
16	Acceleration Phase (ω..-ω..)						
17	Acceleration angle in radians	1.169	radians	θ			
18	Angular Acceleration	34.355	radians/s^2	α = (ω..^2 - ω..^2)/(2θ)			
19	Time to accelerate to full speed	0.261	s	t = (ω.. – ωo) / α			
20	Acceleration Torque at main shaft	1228.676	lb*ft	τ=Iα (convert lbm to lbf!!!)			14744.1171
21	Acceleration HP	20.032	hp	Hp = (τ * RPM) / 5250			
23	Constant Speed Phase (ω..)						
24	Ratio of Cutter tip speed to Belt speed	1.555	:1	Must be greater than 1.5			
25	Weight of sample	53.625	lbm				
26	Angle over which sample is cut (cut angle=cutter angle)	1.559	radians				
27	Time to sweep coal off belt	0.174	s				
28	Sample CG loc in y-axis (approx)	-21.646	in				
29	Velocity of CG of sample @ω..	970.141	ft/min=	16.169	ft/s	v=d/t	
30	Acceleration of sample	185.879	ft/s^2	a = v/t	Using t/2 because the entire samp		
31	Mass of coal buildup on cutter side	248.782	lbm				
32	Deceleration of built up coal	153.280	ft/s^2		Using t/2 because the entire build		
33	Friction of built up coal on belt	124.391	lbf				
34	Force of Coal buildup on cutter side	1308.656	lbf				
35	Torque to accelerate sample	558.394	lb*ft	F = ma = (Wt/32.2) * a			
36	Friction of coal to walls of cutter	53.625	lbs				
37	Friction of sample sliding on the belt	26.813	lbs				
38	Friction from the cutter wiper	30.000	lbs				
39	Torque due to friction	255.400	lb*ft				
40	hp to accelerate sample	13.268	hp				
41	Torque to accelerate and cut the sample	813.794	lb*ft	9765.53	lb*in		
44	Braking Phase (ω..-ω..)						
45	Stopping arc in radians	0.698	radians	θ			
46	Angular deceleration	57.544	radians/s^2	α = (ω..^2 - ω..^2)/(2θ)			
47	Time to decelerate cutter	0.156	sec	t = (ω – ωo) / α			
48	Torque to decelerate rotational components	2058.033	lb*ft	τ=Iα (convert lbm to lbf!!!)			24696.396 lb*
49	hp to decelerate	33.554	hp				99.808 lb_
51	Max Full CycleTorque	2058.033	lb*ft	24696.396	in*lb		
52	Max Full Cycle Torque at Motor shaft	99.808	lb*ft	1197.691	in*lb		
54	Ke per stop	1436.778	lb*ft				
55	Max Power	33.554	hp				

TORQUE

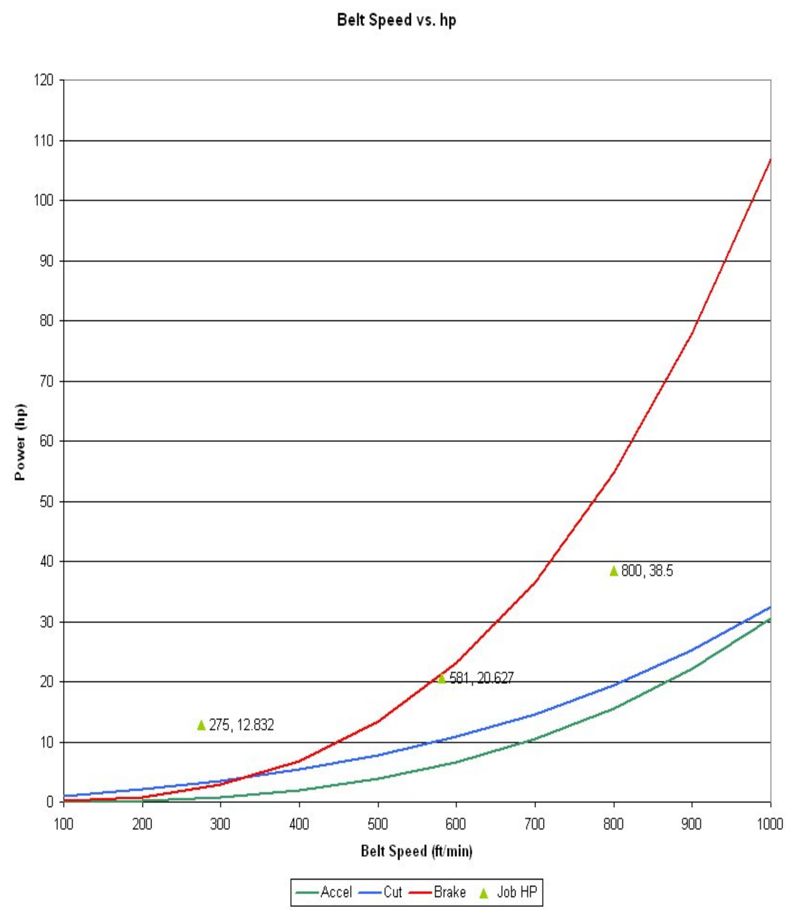


Torque and hp vs. Cutter rpm
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Power (hp)
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Torque (lb*ft)
52
54
56
58
60
62
64
66
68
70
72
74
76
78
80
Cutter RPM
Accel HP
Cut HP
Brake HP
Accel Tq
Cut Tq
Decel Tq

BELT SPEED

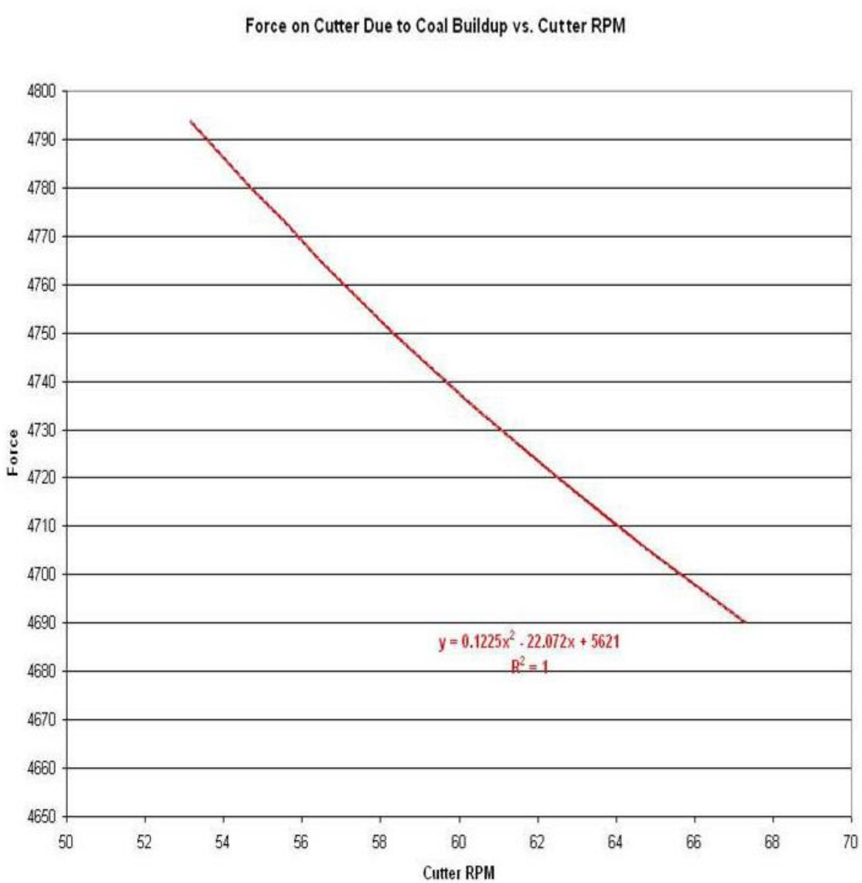


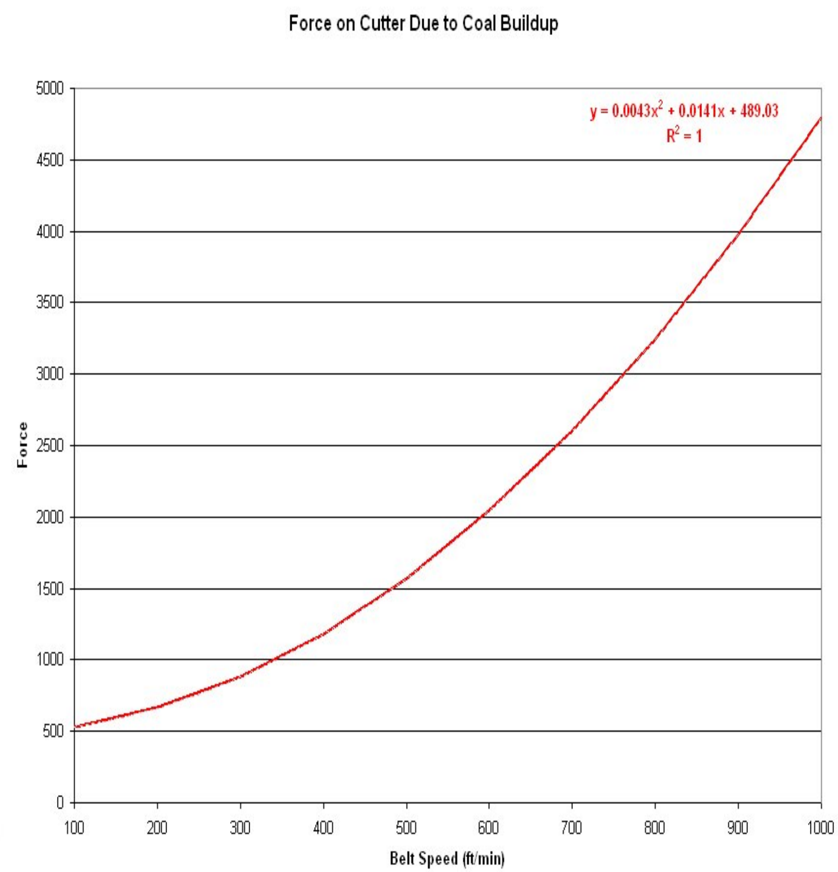
Belt Speed vs. Torque, 72"
y = 0.0105x² + 0.0091x + 0.35
R² = 1
Torque (lb*ft)
Belt Speed (ft/min)
800, 3589
581, 2584
275, 1778
Accel
Cut
Brake
Job Torque
Poly. (Brake)



Belt Speed vs. hp
Power (hp)
Belt Speed (ft/min)
800, 38.5
581, 20.627
275, 12.832
Accel
Cut
Brake
Job HP

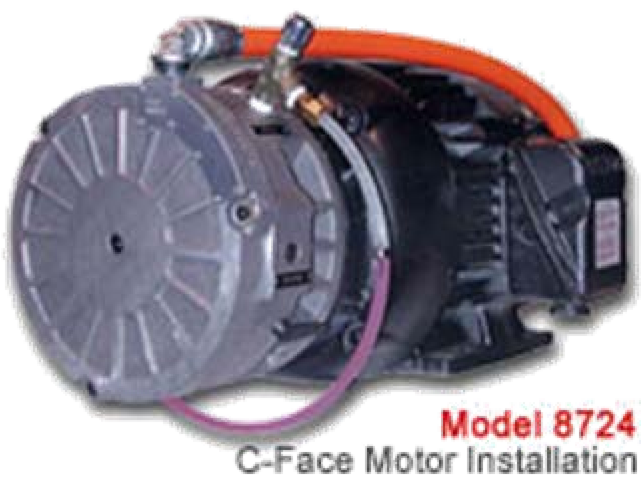
FORCE ON CUTTER

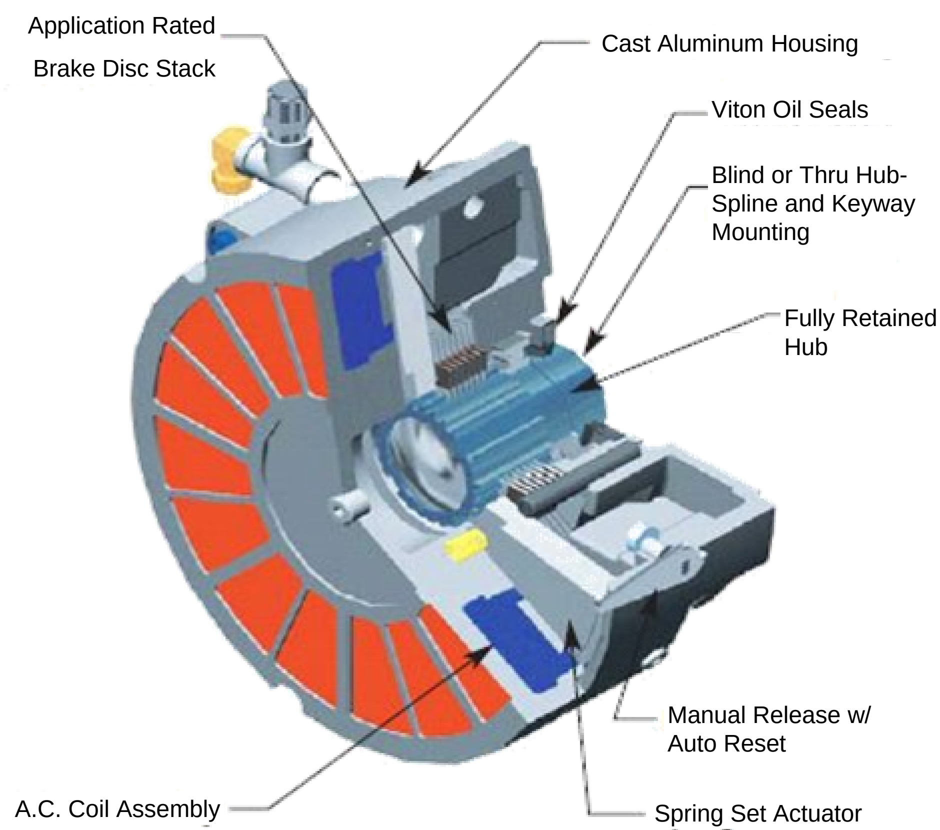




FLUID SHEAR BRAKE

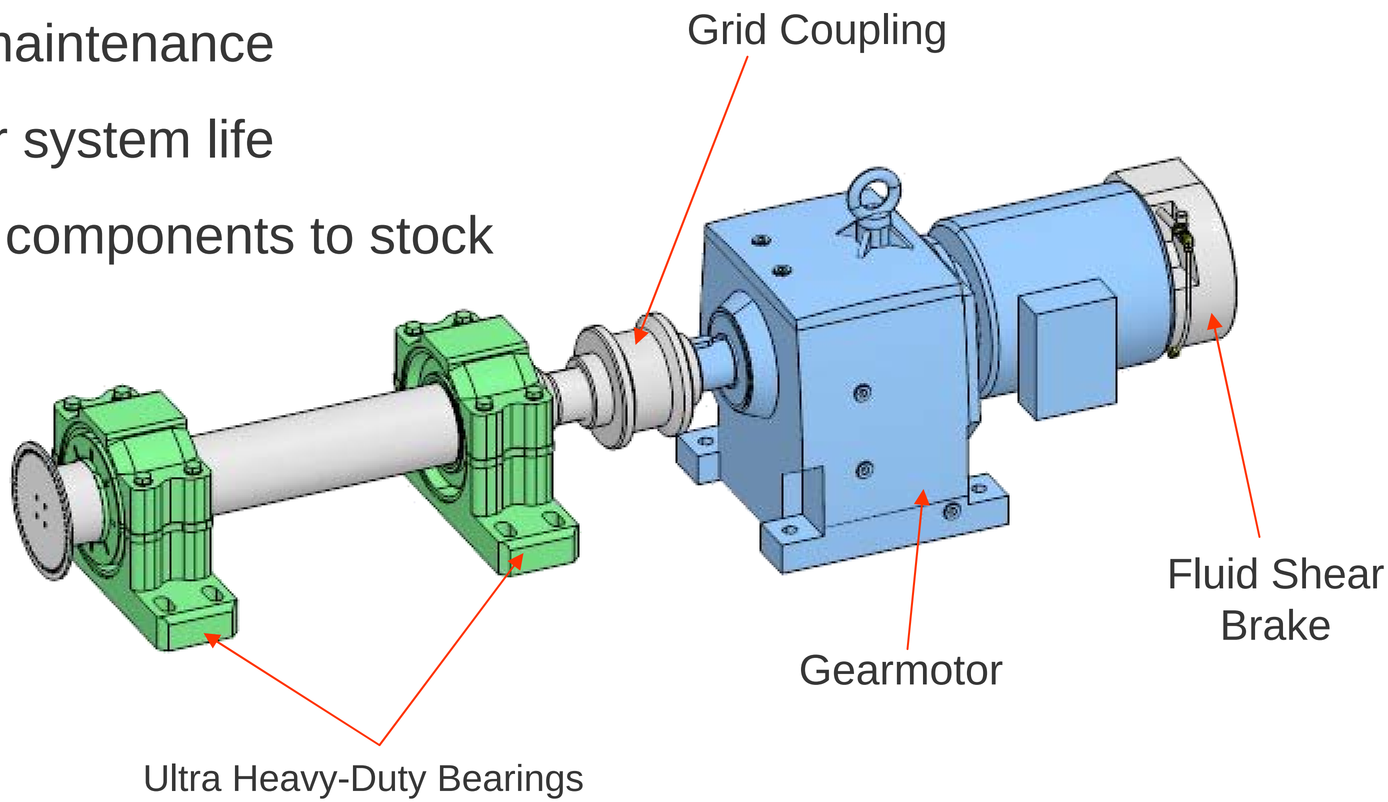
- Nearly eliminates brake maintenance
- Superior stopping capability and response time (<10ms!)
- Potted electric components for superior durability



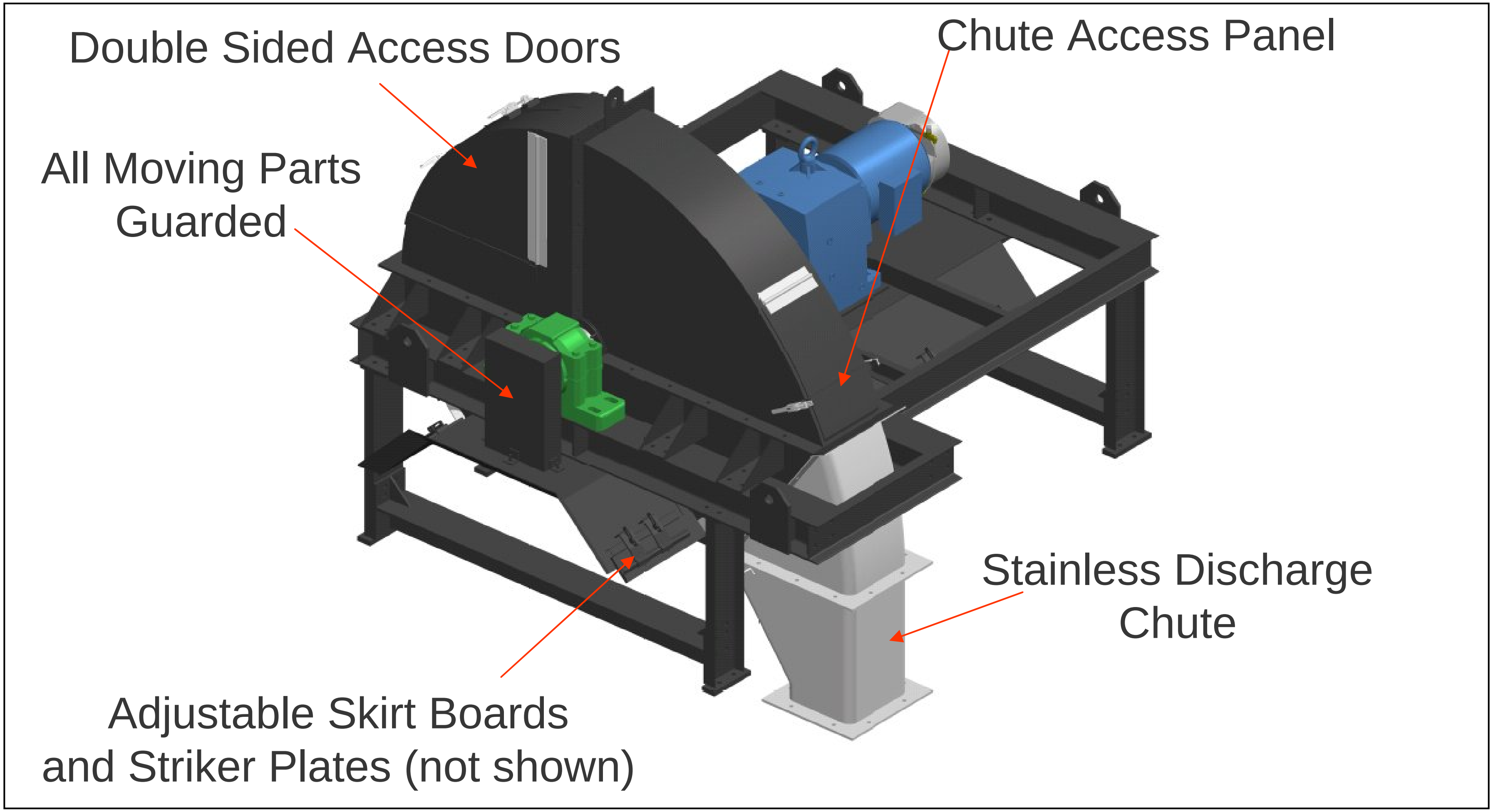


DIRECT DRIVE

- Direct drive eliminates the clutch-brake
- Less maintenance
- Longer system life
- Fewer components to stock

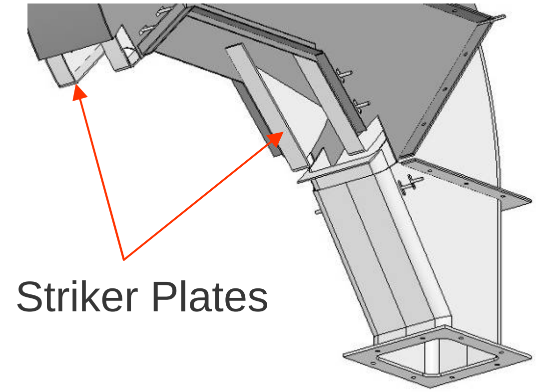


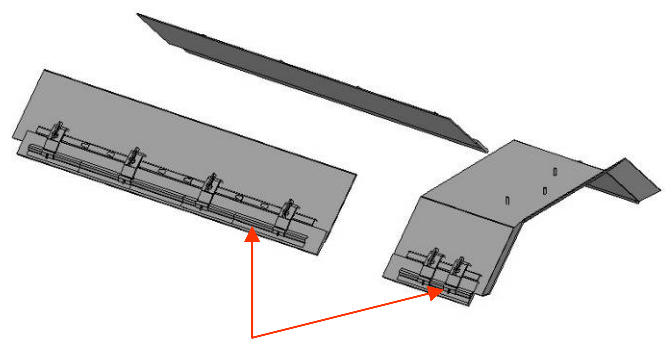
ENCLOSURE FEATURES



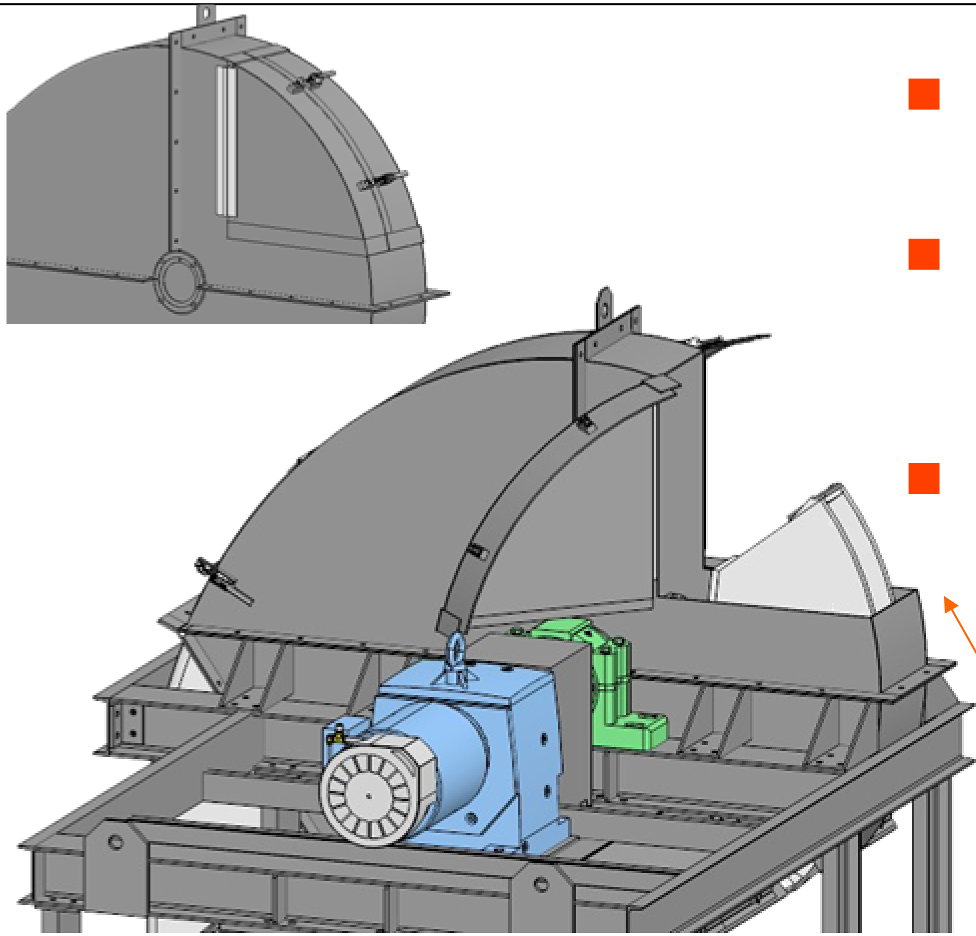
ADJUSTABLE SKIRT BOARDS AND STRIKER PLATES

- Collect all the increment, all the time
- Striker plates ensure only the material within the cutter is collected with the increment.
- Reduce bias, error, and dust
- No residual sample material left on belt
- Keep all non-sample material on the belt, eliminate spillage
- Conforms to ISO, ASTM and other international standards





SIDE HINGED ACCESS DOORS

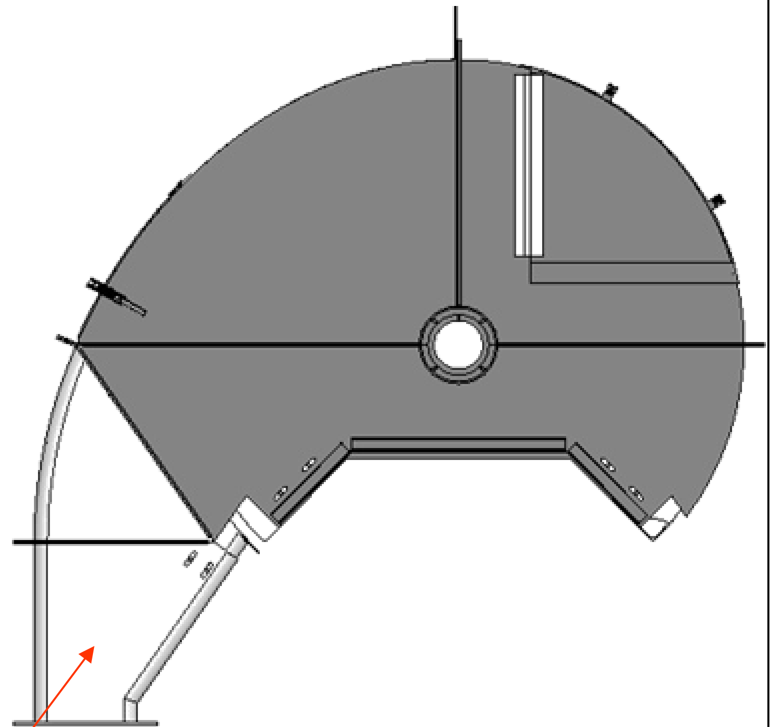


- Allow for easy access without leaning into enclosure
- Electrical safety interlock to prevent operation when doors are open
- Lockable to prevent unauthorized access

Easy Cutter and Wiper Access

SPIRAL ENCLOSURE

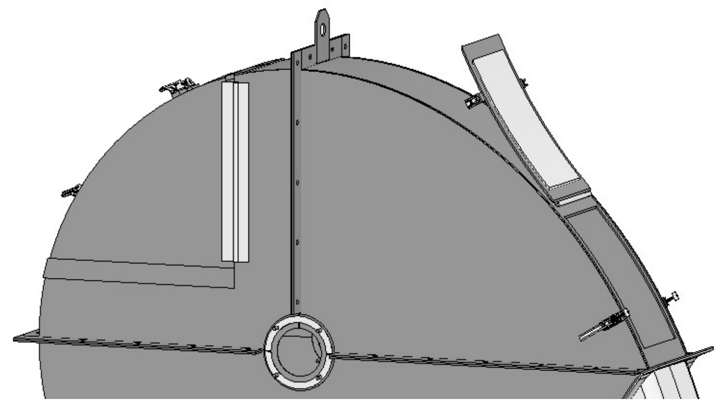
- Material impacts walls at 65º angle
- Prevents ‘mushrooming’ and sticking of sample on enclosure walls
- Maintains material velocity all the way to the discharge flange

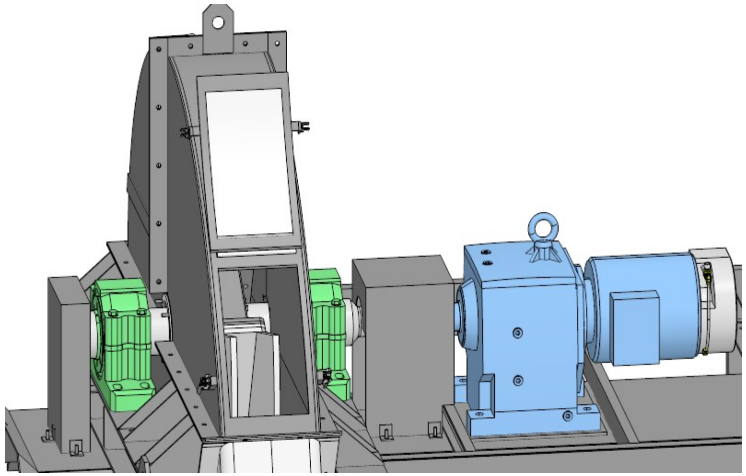


Fully Stainless Steel Chute
With 2” Radius Corners

CHUTE INSPECTION DOOR

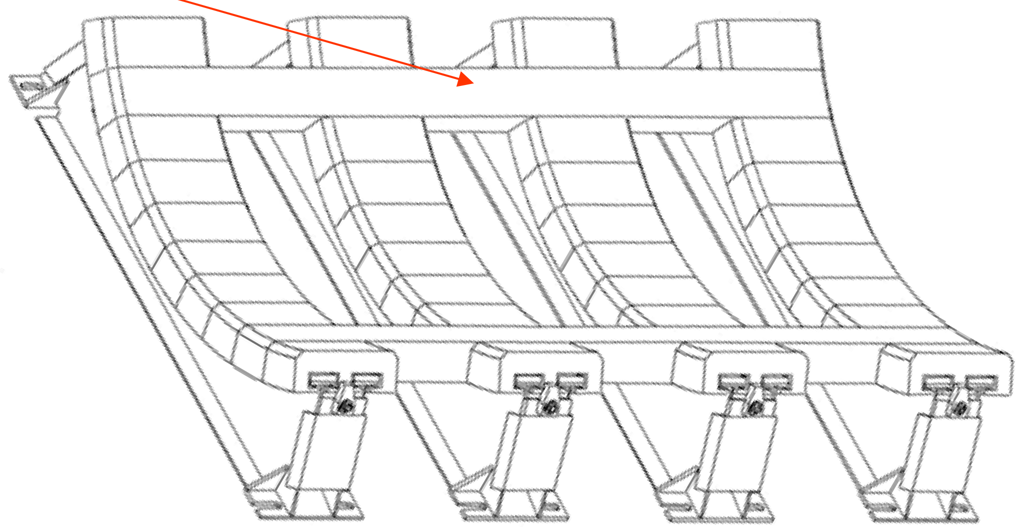
- Easy chute or cutter access
- Lockable latches
- Inner liner to keep inside of enclosure as flat as possible, reducing places for material to stick





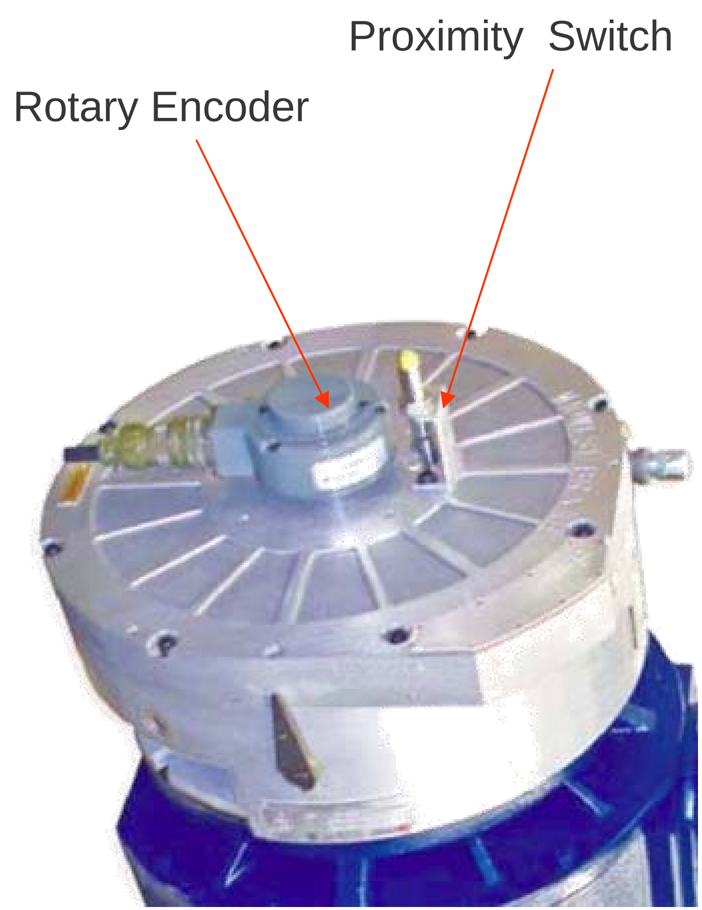
CIRCULAR IMPACT BED

- Conforms belt perfectly to cutter trajectory (training idlers not shown)
- Ensures that no material is left behind by the cutter
- Extra protection along skirt boards to prevent material loss as spillage



OPTIONAL CLOSED LOOP SPEED AND POSITION CONTROL

- Shaft encoder integrated with fluid shear brake or hydraulic motor
  - Allows for real-time feedback to control software
  - Operational speed can be verified and an alarm can be triggered if the correct speed is not reached in the designated angle
  - Any slowing through material can be monitored and accounted for, an alarm can be triggered if conditions change out of nominal parameters
  - Dynamic acceleration and braking control reduces stress on components
  - Park position and acceleration/braking curves precisely defined and monitored, no 'timer based' motion control
  - No 'tuning' necessary once system is set up



OPTIONAL HYDRAULIC DRIVE

- Extreme duty drive
- Fully dynamic motion control
- Extreme torque and shock capacity
- 100% thermal control for full response in any environment
- Very low maintenance
- No need for a gearbox or separate brakes (holding brake and stopping brake included)
- Complete integrated solution
  - Motor
  - Power unit
  - Hydraulic controls
  - Hydraulic system health monitoring

OPTIONS TO MITIGATE HARSH ENVIRONMENT

- Fully stainless steel systems
- Wash-down rated equipment
- Explosion proof electrics (Hazardous environment conditions)
- Epoxy coated components (Highly corrosive applications)
- Galvanized framework
- Stainless hardware

CROSS BELT SAMPLERS – DESIGN RULES

- Rule 1: The cutter aperture must travel at a 90 degree angle to the centerline of the belt being sampled.
- Rule 2: The cutter aperture width must be no less than three times the nominal top size of the material (3d).
- Rule 3: The arc formed from the leading edge to the trailing edge of the sidewalls must be sufficient for the cutter to cover the width of the material on the belt at full CEMA loading.
- Rule 4: The cutter must pass through the entire stream of material during one continuous operation with a minimum cutter velocity at the tip of the cutter near the belting of 1.5 times the velocity of the belt.
- Rule 5: Striker plates for prohibiting the entry of non-sample material must be installed on both the upstream and downstream sides of the cutter exit opening with gaps between the exiting cutter and striker plate held to no more than 10 mm.
- Rule 6: The underlying belting must be securely supported in such a way as to conform the belting to the cutter path (a circle).

CROSS BELT SAMPLERS – DESIGN RULES

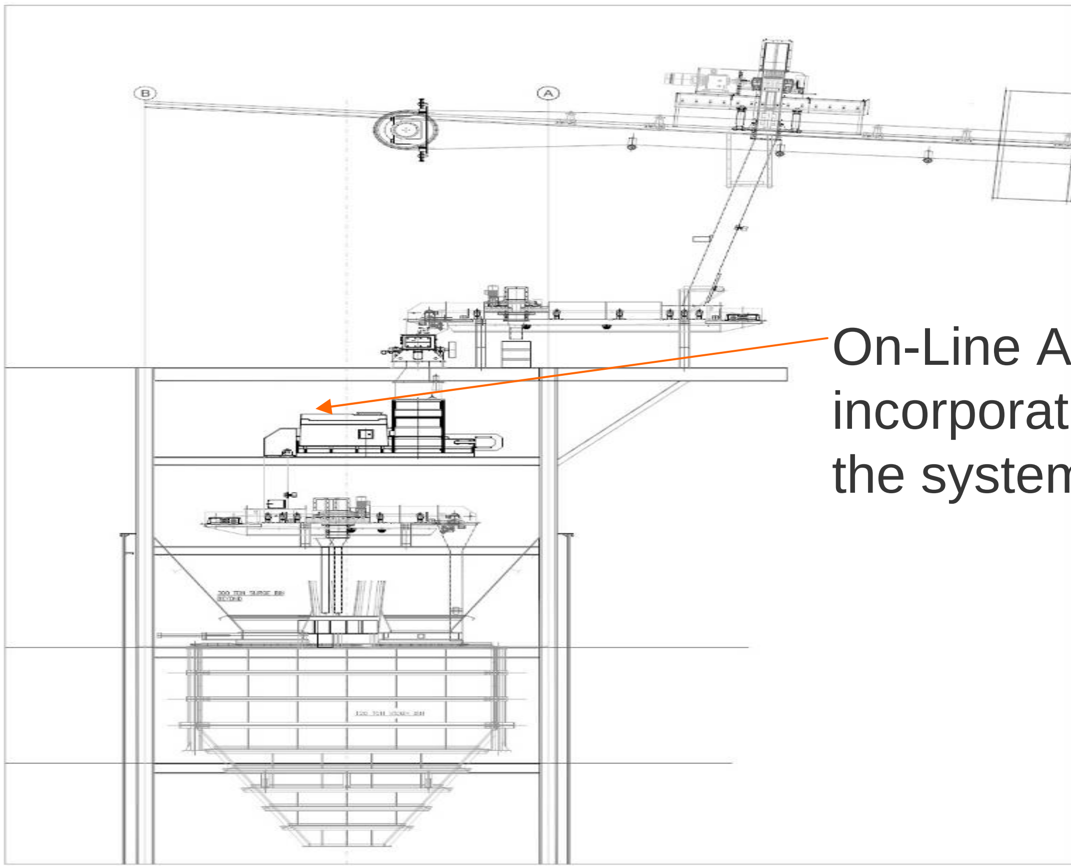
- Rule 7: The gap between the cutter side plates and the conveyor belting must not be greater than 10 mm at any point across the belt.
- Rule 8: The cutter must be equipped at the rear with an effective and durable wiper that cleanly scrapes the belting.
- Rule 9: The cutter must not be fitted with internal supports that could interfere with material entering or exiting the cutter.
- Rule 10: All cutters for belt sizes 900 mm and larger must be counterweighted. This avoids potential structural problems with the conveyor belt.
- Rule 11: All material delimited by the cutter and none other, must be included in the sample.
- Rule 12: No material shall remain in the cutter after the cutter has collected and discharged an increment. This is to be verified visually and by tests of the sampling ratio.

SGS

SGS MECHANICAL SAMPLING SYSTEMS

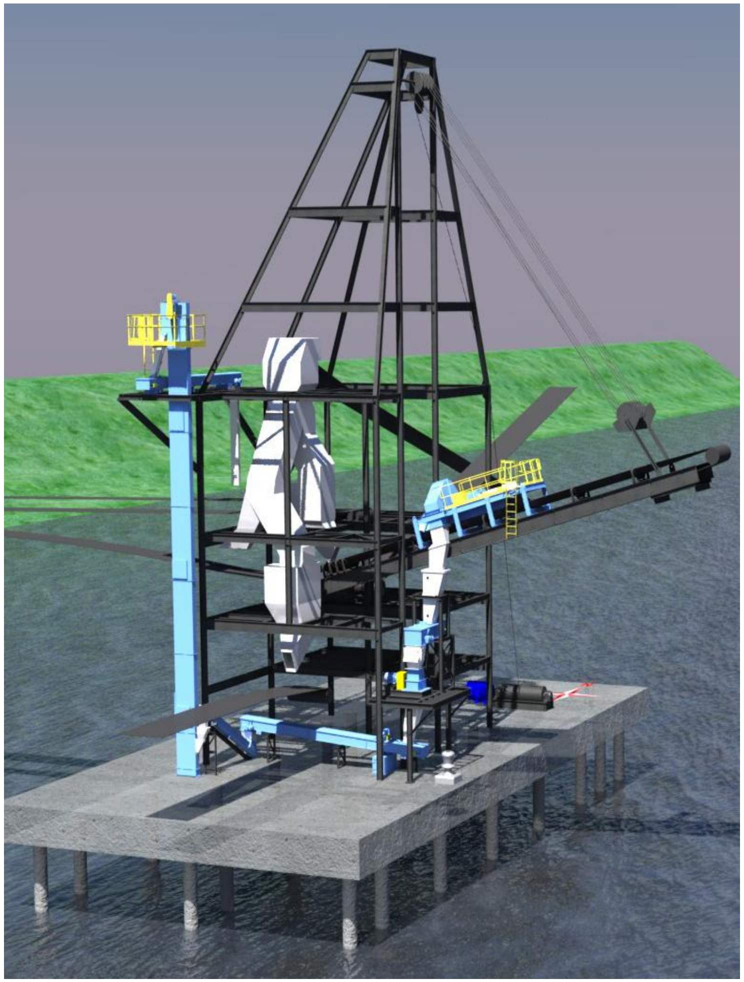
- Fully turn-key sampling systems
  - Samplers (Primary, Secondary, Tertiary)
    - Cross Belt
    - Falling Stream
    - Auger
  - Feed and Discharge Belts
  - All Chute work
  - Power, Instrumentation and Control Integration with Existing Systems

MSS DESIGNED INTO NEW OPERATIONS



On-Line Analyzer incorporated into the system.

COMPLICATED INTEGRATION OF A MSS INTO AN EXISTING FACILITIES



- Primary sampler mounted on a loading boom that is raised and lowered.

OTHER SGS MECHANICAL SAMPLING SYSTEM SERVICES

- Bias Testing of Sample Systems
- Sampling System Inspection Services
- Engineering Studies to design and justify
- Field installation and Project management
- Integration of On-Line Analyzers into the system
- Operation and maintenance services

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