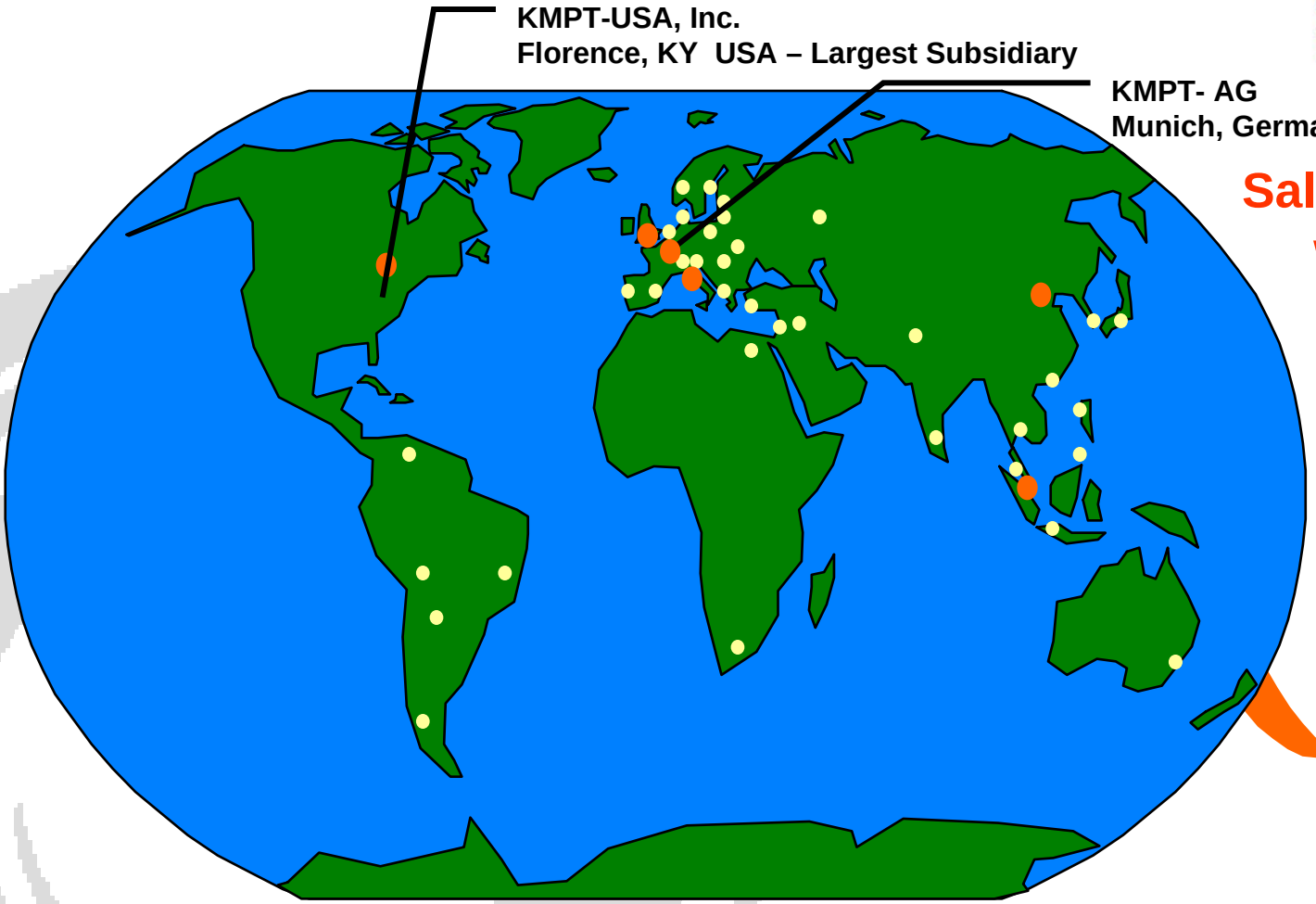
Reinhold Environmental Ltd.

2006 APC Round Table & Expo Presentation

July 16-18, 2006, Columbus, OH

Innovative, Reliable, Efficient Solutions for Mechanical and Thermal Solid / Liquid Separation

VZ 160/6.3-G Vertical Centrifuge



Sales Partners World wide in over 60 Countries

- Subsidiaries and Service Centers:
  USA, Great Britain, France, Italy, China, Singapore

KMPT-USA, Inc. - Florence, KY

KMPT-USA Capabilities

- Primary Customer Responsibility for No. America
- Sales and Marketing
- Mechanical Design, Process, & Systems Engineering
- Product Development
- World Class Test Center
- Manufacturing of Equipment, Parts and Controls Systems
- $3 Million Spare Parts Inventory
- Well Experienced Field Service Technicians
- In-House Repair Center

Main Product Lines:

- Centrifuges
- Filters
- Dryers
- Control Systems

Krauss-Maffei Vertical Basket Centrifuge

Drawing from many decades of vertical basket centrifuge design experience, this series was developed specifically to meet the rugged requirements for FGD gypsum dewatering.

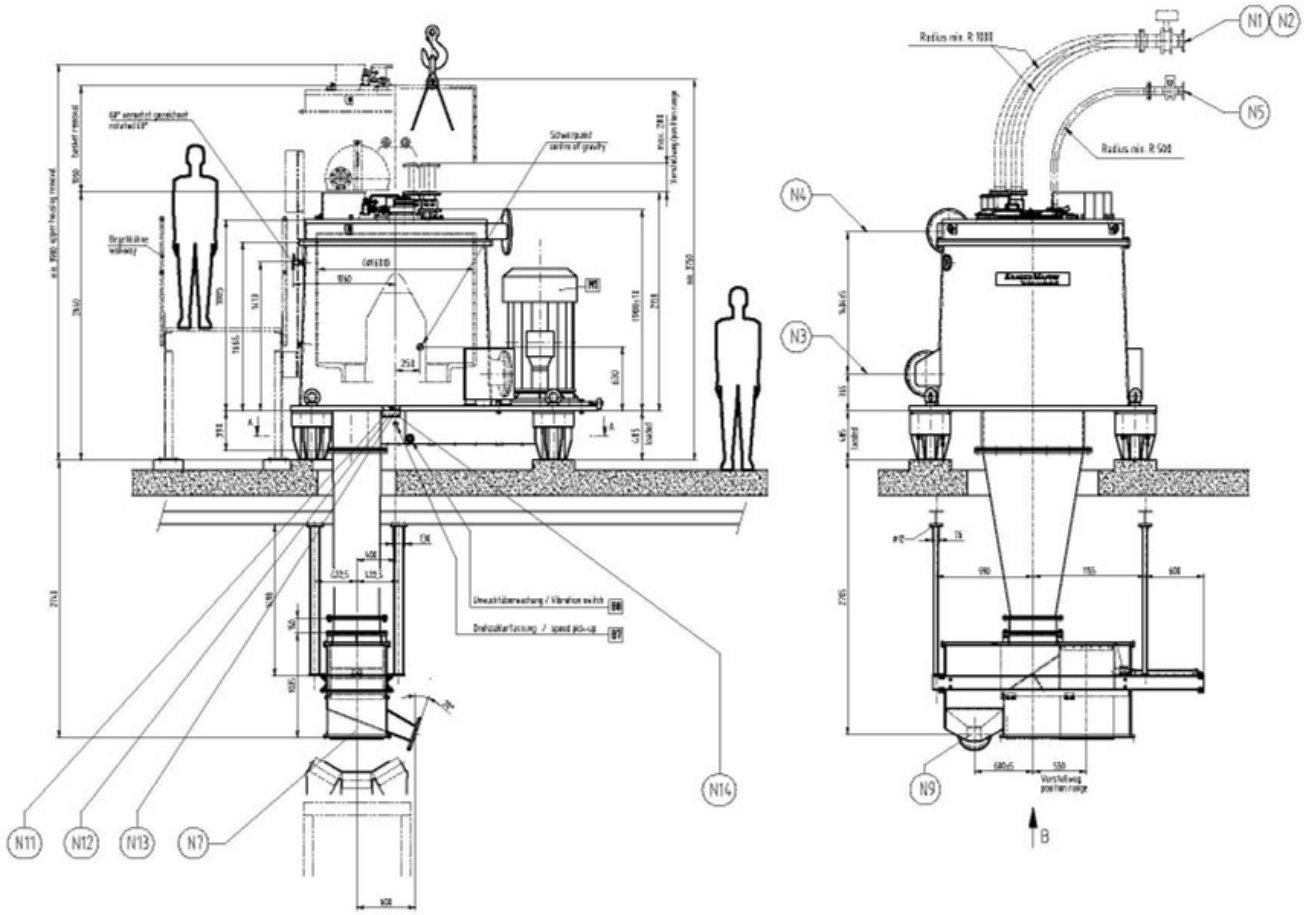
Timeline: The VZ160/5-G was introduced in 1982

The VZ160/6.3-G was introduced in 1994

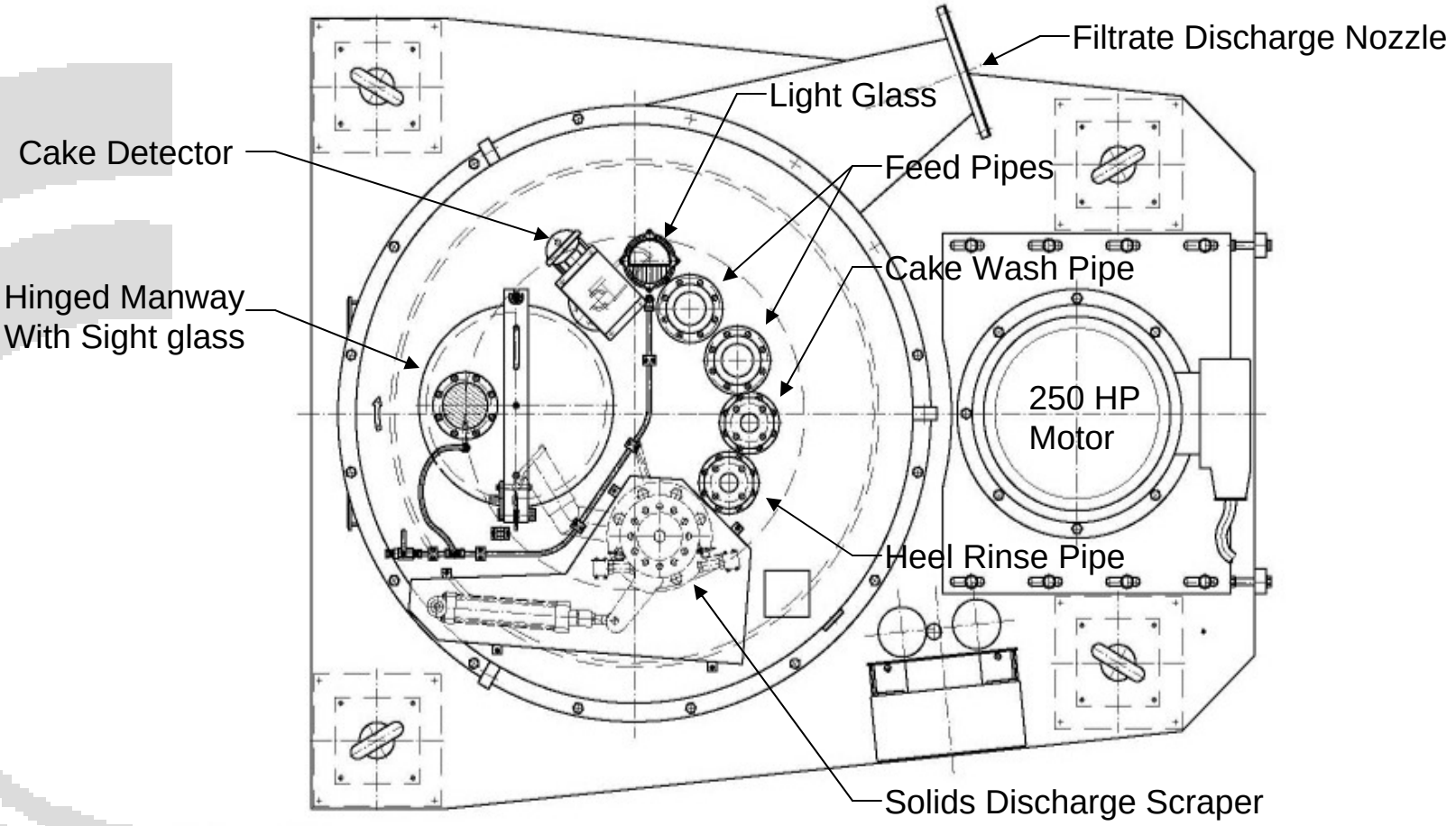
VZ 160/6.3-G Technical Data

Basket Inside Diameter:	1,600 mm (63.0 inch)
Basket Inside Height:	1,250 mm (49.2 inch)
Basket Top Rim Diameter:	1,120 mm (44.0 inch)
Basket Nominal Volume:	1,250 liters (44 ft^3)
Basket Filtration Area:	6.3 m^2 (68 ft^2)
Maximum Speed:	800 RPM (570 x G)
Nominal Cake Load:	1,660 kg (3,650 lb)
Operating Weight:	15,250 kg (33,620 lb)

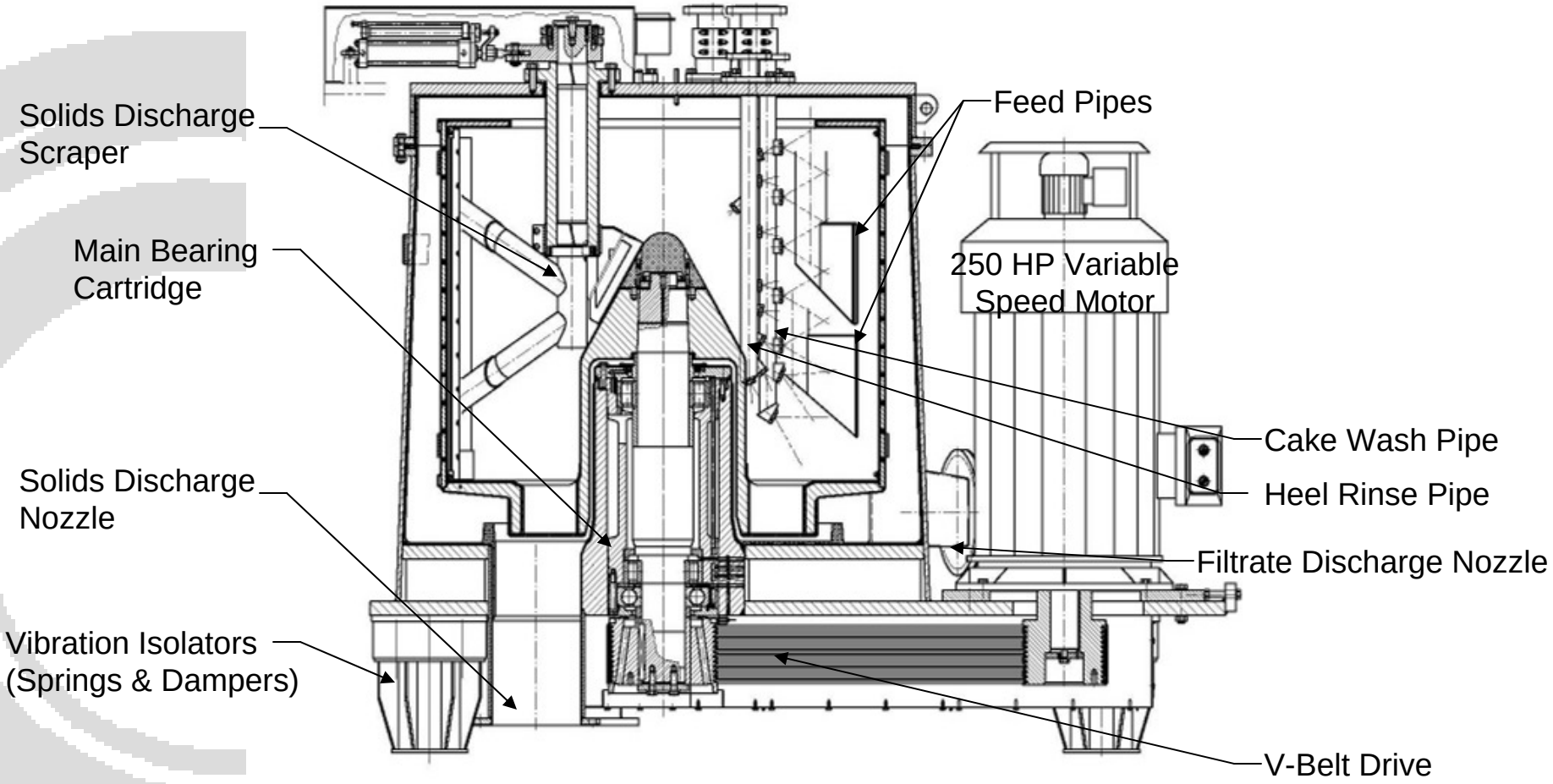
Vertical Centrifuge – Layout



Vertical Centrifuge – Plan View



Vertical Centrifuge – Cross Section



Method of Operation – Cycle Sequence

1. The machine accelerates from 25 to 800 RPM.
2. Both feed valves open during acceleration once 600 RPM is reached at a rate of 750-800 GPM. Feed continues, allowing the basket to overflow for a time period. The solids settle as the liquid migrates towards the top rim, overflowing clarified supernatant until the end of the overflow step. Feed ends when the basket is 100% full of solids.
3. Wash begins immediately following the end of feed. Wash quantity and time is determined by the incoming feed chlorides content.

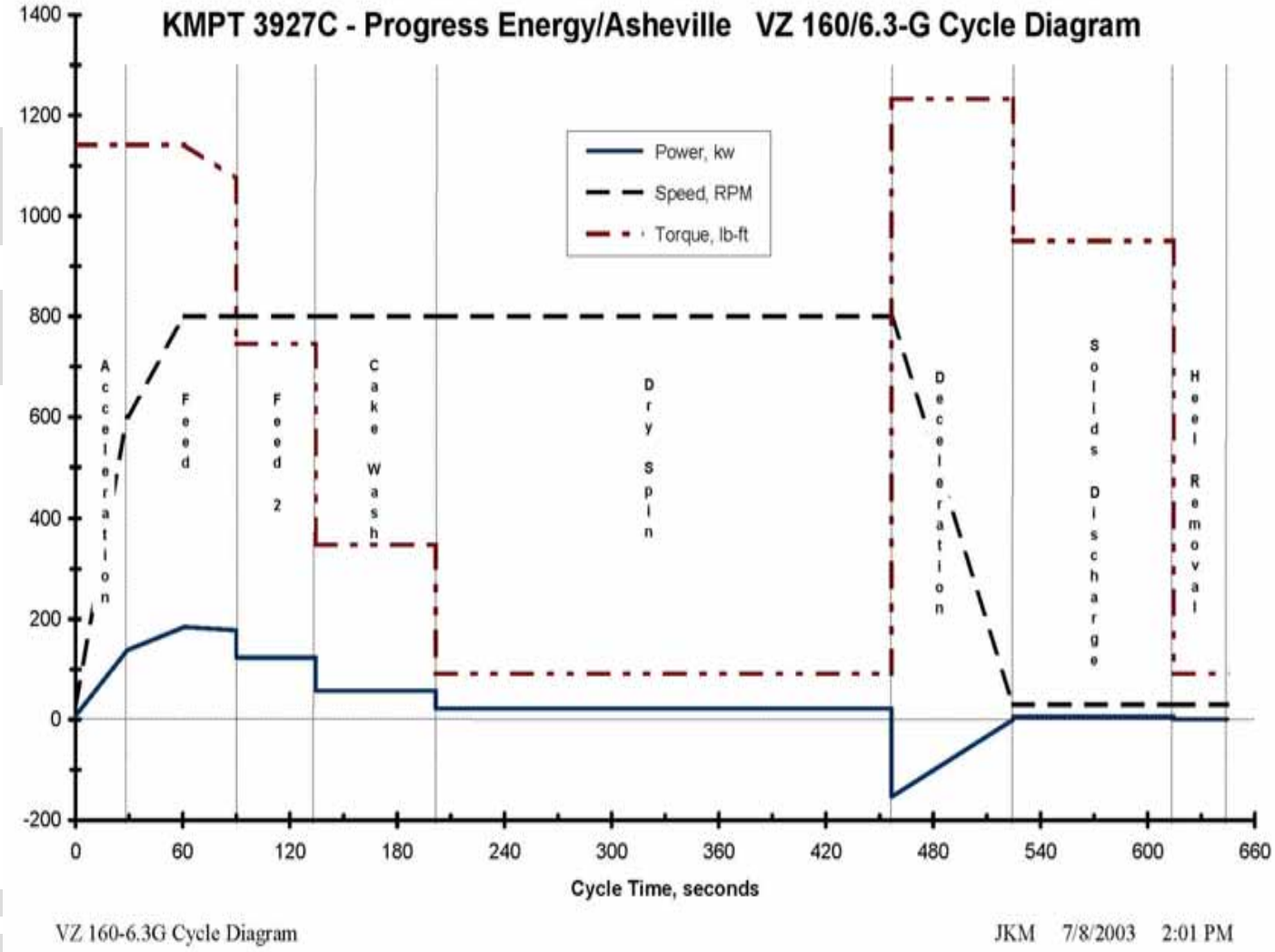
Method of Operation – Cycle Sequence

4. Following wash, the cake is allowed to spin dry for a time period, determined by the desired final moisture content. For example, 90 seconds will reach 9-10%, 240 seconds will reach 5-6%.
5. Following spin, the machine decelerates to discharge speed, 25 RPM. During this step the regenerative AC variable frequency drive recovers power from the kinetic energy of the rotating mass.
6. Once at low speed, the diverter travels to the discharge position and the scraper unloads the cake to the transfer conveyor below.

Method of Operation – Cycle Sequence

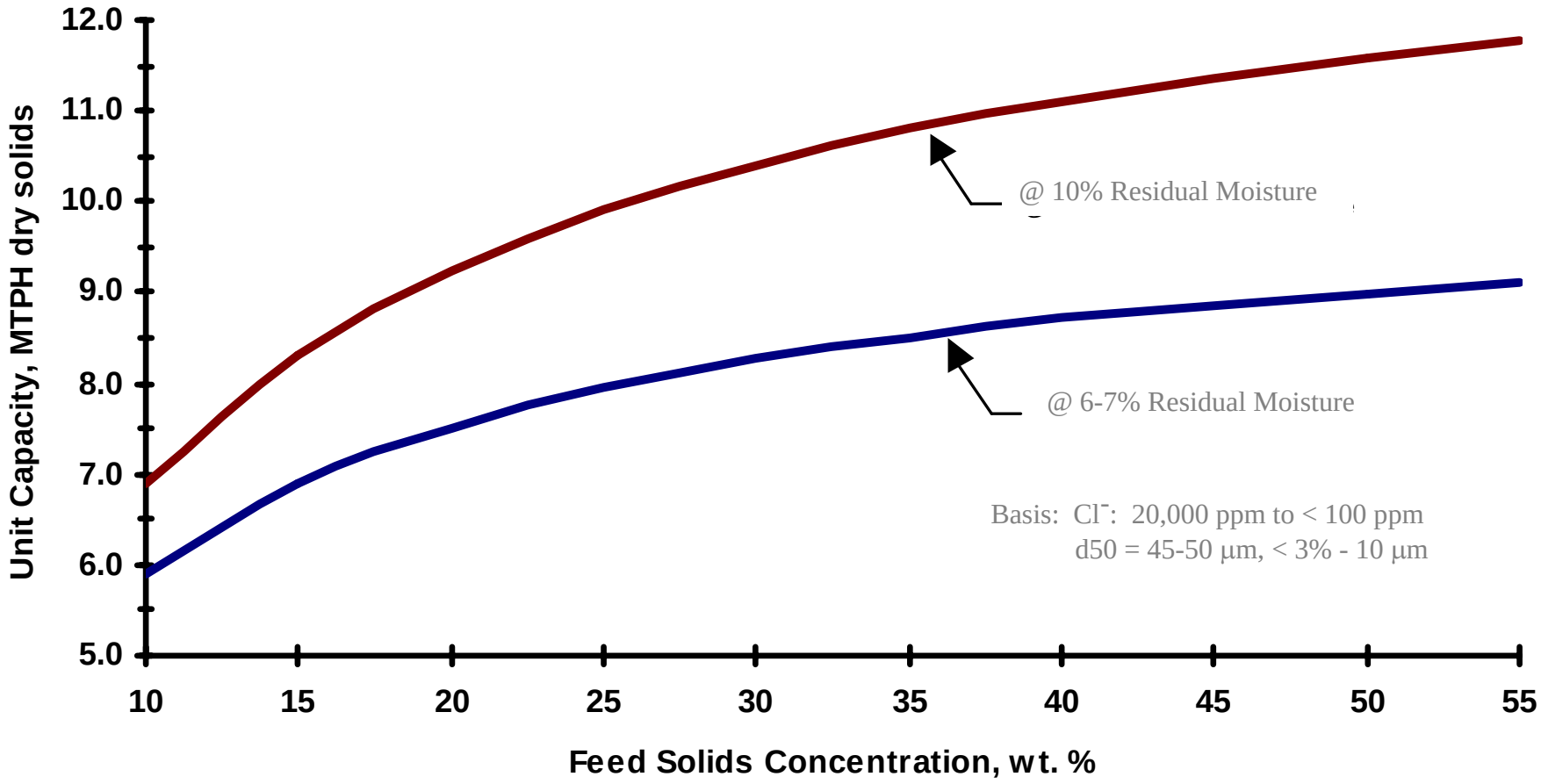
7. Every 3-4 cycles the residual heel cake is removed to maintain filterability. For this step the diverter returns to the home (diverted) position, and the heel rinse system sprays the heel from the cloth surface and out the bottom of the basket. This is done at 25 RPM.
8. The next cycle then begins (the machine again accelerates from 25 to 800 RPM).

VZ 160/6.3-G Vertical Centrifuge



VZ 160/6.3-G Vertical Centrifuge

VZ 160/6.3-G Capacity versus Feed Concentration



Vertical Centrifuges – Typical Installation

Vertical Centrifuges – Schoelven, Germany

Vertical Centrifuges – Asheville, NC Units 1 & 2

Progress Energy – Asheville, NC Power Station

Generating Capacity:	2 x 200 MW
Gypsum Production Rate:	25 TPH dry basis
Thickened Slurry Concentration:	45% by weight
Feed Chlorides Concentration:	20,000 ppm Cl^-
Wash Ratio (wash/dry solids):	< 0.4 lb/lb for <100 ppm Cl^- in the cake
Operating Units @ 10% RM:	Two (plus two spare)
Operating Units @ 6% RM:	Three (plus one spare)

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Less floor space is required by centrifuges – thus reduced installation and building costs. By nature of their compact arrangement, centrifuges require only about 1/3 the space required of vacuum belt filters. In retrofit applications where space is tight, this can represent an enormous cost savings.
- Vacuum belt filter's high power vacuum systems require medium voltage infrastructure not needed with centrifuges.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- High reliability of centrifuges means a lower percentage of spare capacity needs to be installed to meet ~100% plant availability. Up to six operating centrifuges require only one spare centrifuge. Often with filters, one operating unit and one spare are installed, for 100% installed spare capacity.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Depending on plant size, Centrifuges can be the lower capital cost option. For example, this was the case at Progress Energy - Asheville, NC without even considering the building cost savings.
- As plant size increases, the capital cost relationship shifts to favor Vacuum Belt Filters. Our analysis shows 50-60 TPH gypsum rate to be about break even capital comparison.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Centrifuges will consistently reach very low residual cake moisture content, usually below 6% and sometimes can reach as low as 4%. Belt filters usually only reach 9-10% cake moisture. Since during wallboard production all moisture must be thermally driven off, this can represent an enormous cost savings of about $1.60/ton*.

*Sources/Basis: US Gypsum drying cost estimate of 0.045 MMBTU/% RM/ton
Natural gas cost based at $9.00/MMBTU
Cake moisture differential of 4 percentage points

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Centrifuges produce much less power compared to vacuum belt filters, under 4-5 kwh/ton compared to about 10-12 kwh/ton for vacuum filters operating at full load.
- Often filters operate at reduced rates (e.g. operating both the operating and spare filter at reduced rates to reach lower moisture). Since the vacuum system pulls full power regardless of load, specific power consumption increases up to 20 kwh/ton.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Transportation costs to haul a dryer cake are less. While this cost varies tremendously in each case, this is an evaluation point that should not be overlooked.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Maintenance costs are low for centrifuges – typically requiring annual cloth changes and knife sharpening, bi-annual v-belt replacement, and bearing maintenance every 10 years or longer.
- Vacuum belt filters require frequent and difficult belt changes, bearing and roller maintance, and vacuum system maintenance.

Advantages of Vertical Basket Centrifuges compared to Vacuum Belt Filters:

- Centrifuges are versatile in ability to handle process variations, lower feed concentration, lower slurry temperature, varying gypsum composition and particle size while consistently producing in-spec product.
- There is never a need to utilize hot water or steam as a means to reach lower moisture.
- Centrifuges are totally enclosed, quiet and require almost no operator attention, resulting in an ergonomically friendly and neat environment.

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

Case 1 : 600-900 MW Power Station

Basis:

60 TPH FGD Gypsum (dry basis)
50-55% w/w Feed Solids Concentration
20,000 ppm Chloride Ions in Feed
0.4 Wash Ratio
Comparisons for 10% RM and 6% RM
Mean Particle Size Range = 45 micron
Costs are in current dollars and exchange rates
Costs do not include interest

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

Case 1 : 600-900 MW (60 TPH)

Equipment:	*VZ 160/6.3-G Centrifuges*	*VZ 160/6.3-G Centrifuges*	*60 m^2 Belt Filters*
Cake Moisture:	*10% RM*	*6 % RM*	*10% RM*
No. Operating Units:	*5*	*6*	*1*
No. Spare Units:	*1*	*1*	*1*
No. Total Units:	*6*	*7*	*2*

Note: See sizing calculations for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

1. Capital Cost Comparison for Case 1:

Equipment:	*VZ 160/6.3-G 5 + 1 units*	*VZ 160/6.3-G 6 + 1 units*	*60 m^2 Filters 1 + 1 units*
1.1 Equipment Cost:	*$2,100,000*	*$2,450,000*	*$2,000,000*
1.2 Building Cost:	*$130,500*	*$152,250*	*$570,000*
1.3 Peripheral Cost:	*$340,000*	*$355,000*	*$200,000*
1.4 Installation Cost:	*$1,220,000*	*$1,402,500*	*$1,100,000*
Total Installed Cost:	***$3,790,500***	***$4,359,750***	***$3,870,000***

Note: See handout for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

2. Operating Cost Comparison over 20 Year Life for Case 1:

Equipment:	*VZ 160/6.3-G 5 + 1 units*	*VZ 160/6.3-G 6 + 1 units*	*60 m^2 Filters 1 + 1 units*
2.1 Power Cost:	*$1,632,000*	*$2,016,000*	*$5,280,000*
2.2 Cake Drying Cost:	*$34,560,000*	*$20,736,000*	*$34,560,000*
2.3 Transportation Cost:	*$128,000,000*	*$122,553,200*	*$ 128,000,000*
2.4 Maintenance Cost:	*$710,000*	*$850,000*	*$2,300,000*
Total Operating Cost:	***$164,902,000***	***$146,155,200***	***$170,140,000***

Note: See handout for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

3. Summary: Total Cost Comparison over 20 Year Life for Case 1:

Equipment:	*VZ 160/6.3-G 5 + 1 units*	*VZ 160/6.3-G 6 + 1 units*	*60 m^2 Filters 1 + 1 units*
Total Installed Cost:	***$3,790,500***	***$4,359,800***	***$3,870,000***
Total Operating Cost:	***$164,902,000***	***$146,155,200***	***$170,140,000***
Total Overall Cost:	***$168,692,500***	***$150,515,000***	***$170,140,000***
Total Centrifuge Savings over 20 Years:	***$5,317,500***	***$23,496,000***	***-***

Note: See handout for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

Case 2 : 1500-2500 MW Power Station

Basis:

150 TPH FGD Gypsum (dry basis)
50-55% w/w Feed Solids Concentration
20,000 ppm Chloride Ions in Feed
0.4 Wash Ratio
Comparisons for 10% RM and 6% RM
Mean Particle Size Range = 45 micron
Costs are in current dollars and exchange rates
Costs do not include interest

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

Case 2 : 1500-2500 MW (150 TPH)

Equipment:	*VZ 160/6.3-G Centrifuges*	*VZ 160/6.3-G Centrifuges*	*60 m^2 Belt Filters*
Cake Moisture:	*10% RM*	*6 % RM*	*10% RM*
No. Operating Units:	*12*	*15*	*3*
No. Spare Units:	*2*	*2*	*1*
No. Total Units:	*14*	*17*	*4*

Note: See sizing calculations for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

1. Capital Cost Comparison for Case 2:

Equipment:	*VZ 160/6.3-G 12 + 2 units*	*VZ 160/6.3-G 15 + 2 units*	*60 m^2 Filters 3 + 1 units*
1.1 Equipment Cost:	*$4,900,000*	*$5,950,000*	*$4,000,000*
1.2 Building Cost:	*$304,500*	*$369,750*	*$1,140,000*
1.3 Peripheral Cost:	*$710,000*	*$755,000*	*$420,000*
1.4 Installation Cost:	*$2,805,000*	*$3,352,500*	*$2,210,000*
Total Installed Cost:	***$8,719,500***	***$10,427,250***	***$7,770,000***

Note: See handout for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

2. Operating Cost Comparison over 20 Year Life for Case 2:

Equipment:	*VZ 160/6.3-G 12 + 2 units*	*VZ 160/6.3-G 15 + 2 units*	*60 m^2 Filters 3 + 1 units*
2.1 Power Cost:	*$4,080,000*	*$5,040,000*	*$13,200,000*
2.2 Cake Drying Cost:	*$86,400,000*	*$51,840,000*	*$ 86,400,000*
2.3 Transportation Cost:	*$320,000,000*	*$306,383,000*	*$ 320,000,000*
2.4 Maintenance Cost:	*$1,700,000*	*$2,120,000*	*$7,140,000*
Total Operating Cost:	***$412,180,000***	***$365,383,000***	***$426,740,000***

Note: See handout for more specific information

Life Cycle Cost Comparison: Centrifuges vs. Belt Filters

3. Summary: Total Cost Comparison over 20 Year Life for Case 1:

Equipment:	*VZ 160/6.3-G 12 + 2 units*	*VZ 160/6.3-G 15 + 2 units*	*60 m^2 Filters 3 + 1 units*
Total Installed Cost:	***$8,719,500***	***$10,427,250***	***$7,770,000***
Total Operating Cost:	***$412,180,000***	***$365,383,000***	***$426,740,000***
Total Overall Cost:	***$420,899,500***	***$375,810,250***	***$434,840,000***
Total Centrifuge Savings over 20 Years:	***$13,940,500***	***$59,029,750***	***-***

Note: See handout for more specific information

Installation References

- Over 300 installations worldwide
- US centrifuge installations dating back to 1985
- See FGD Reference List for specific information
- See contact list for US plant references

Summary

- Vertical basket centrifuges are a viable alternate technology to be considered, especially where low cake moisture, power consumption, unusual process requirements or space requirement are important considerations.
- For gypsum rates up to 40-50 TPH, vertical basket centrifuges should be capital competitive with vacuum belt filters.
- Life cycle cost analyses should favor centrifuges.

Questions?

For further information or to discuss your particular application, please feel free to contact Jim McGillicuddy at:

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