Notes on Industrial Loads

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Large Industrial Loads

Loads served by a dedicated point of delivery
(indicative scales)

Site	POI kV	Load	Generation	
			Synch	Solar
Oil refinery	115kV	300MW	150MW	-
Oilfield production	115kV	150MW	200MW	-
LNG production	>115kV	600MW	800MW	-
Steel mill	115kV	150MW	100MW	-
Paper mill	69kV	30MW	20MW	-
Mine	115kV	50MW	-	-
Semiconductor fab	115kV	25MW	-	1 MW
Data server farm	230kV	200MW	-	50 MW

Industrial Loads on Mixed Substations

Three 150KVA transformers on two poles

Road material quarry

2 conveyer belts	2*60KW	(high starting torque)
Crusher	1*50KW	(variable torque)
Resistive heating	1*50KW	(asphalt tank)
Fans/pumps	2*25KW	(dust abatement)

Dairy

Small process loads	~100KW	
Refrigeration	2*100KW	(screw compressors)
Fans	~ 20KW	

Modeling should reflect scale and level of definition

Large

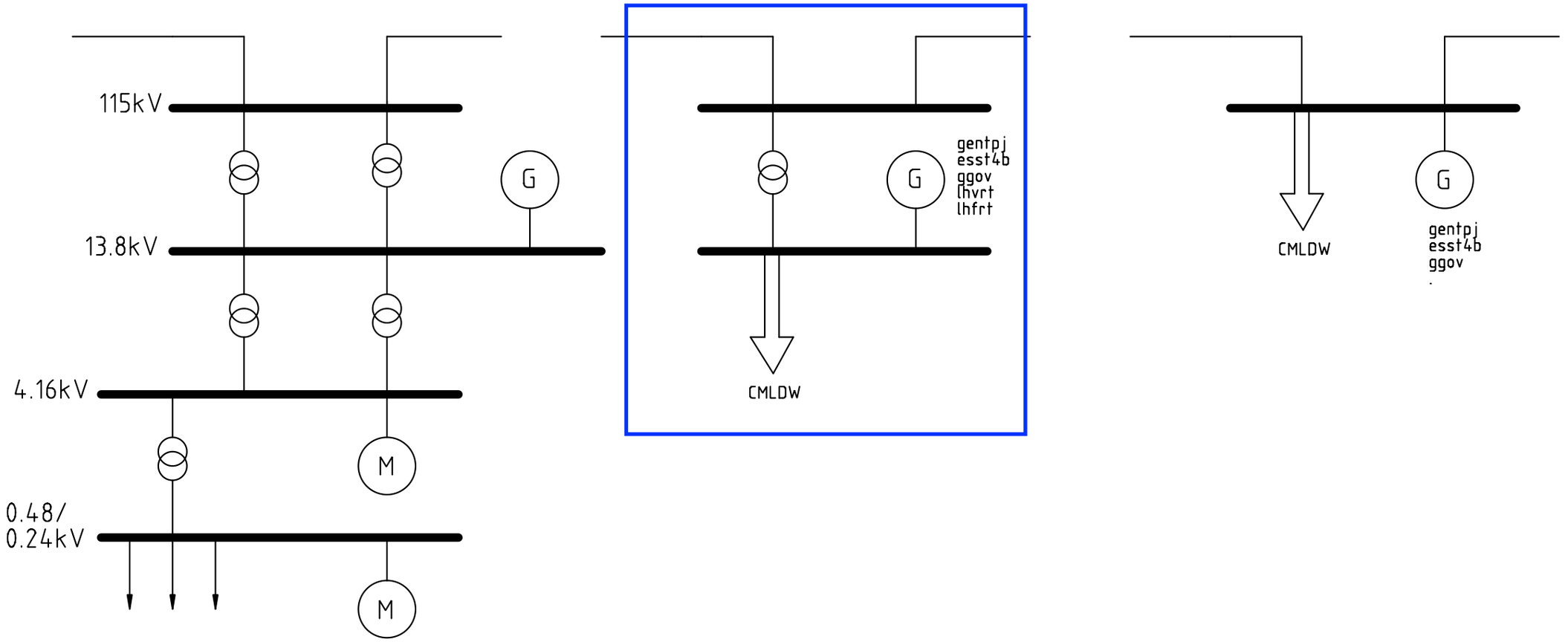
Well defined

Identified

Somewhat defined

Assumed

Loosely defined



Legacy small industrial Loads

Industrial load is predominantly motor load

- Driven load characteristics strongly affect the properties needed in motors
  - Fans, pumps, compressors
  - Conveyer belts, presses, crushers

Motor load may be similar to residential/commercial load or not

- Single phase motors in refrigeration systems
- Three phase motors driving conveyers

Response to transmission system disturbances is well understood

New and future Industrial Loads

No longer predominantly direct connected motors

Short term frequency/power characteristic may be set by the drive program, not by the physics of the driven load

Driven loads have small/uncertain influence on real power characteristic 'seen' at power supply terminals

Details of adjustable speed drives may influence reactive power characteristic 'seen' at power supply terminals

Details of drives may influence behavior in the wake of transmission system disturbances

Response (electrical) to disturbances is less well understood

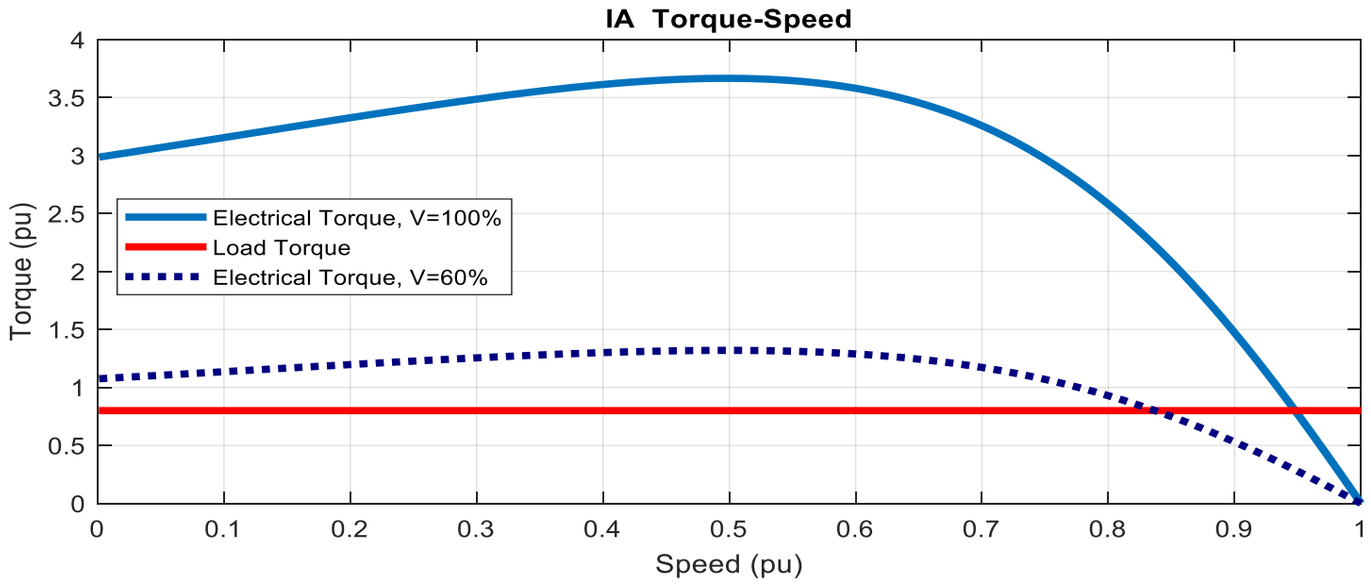
Behavior following disturbances

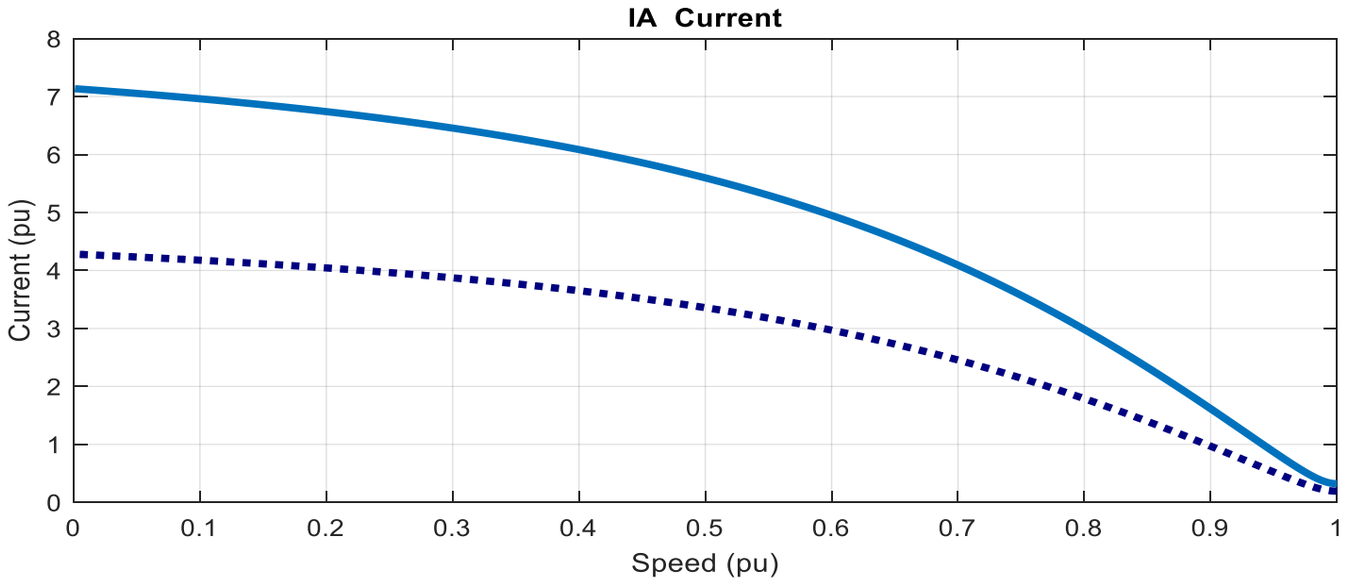
Tripping protocol is likely to be that of the process

e.g. Do not want to trip a downstream conveyer but leave the upstream one running)

Likely to lock out after tripping

Cross tripping to protect process


IA Torque-Speed
Torque (pu)
Speed (pu)
Electrical Torque, V=100%
Load Torque
Electrical Torque, V=60%
0
0.5
1
1.5
2
2.5
3
3.5
4
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9


IA Current
Current (pu)
Speed (pu)
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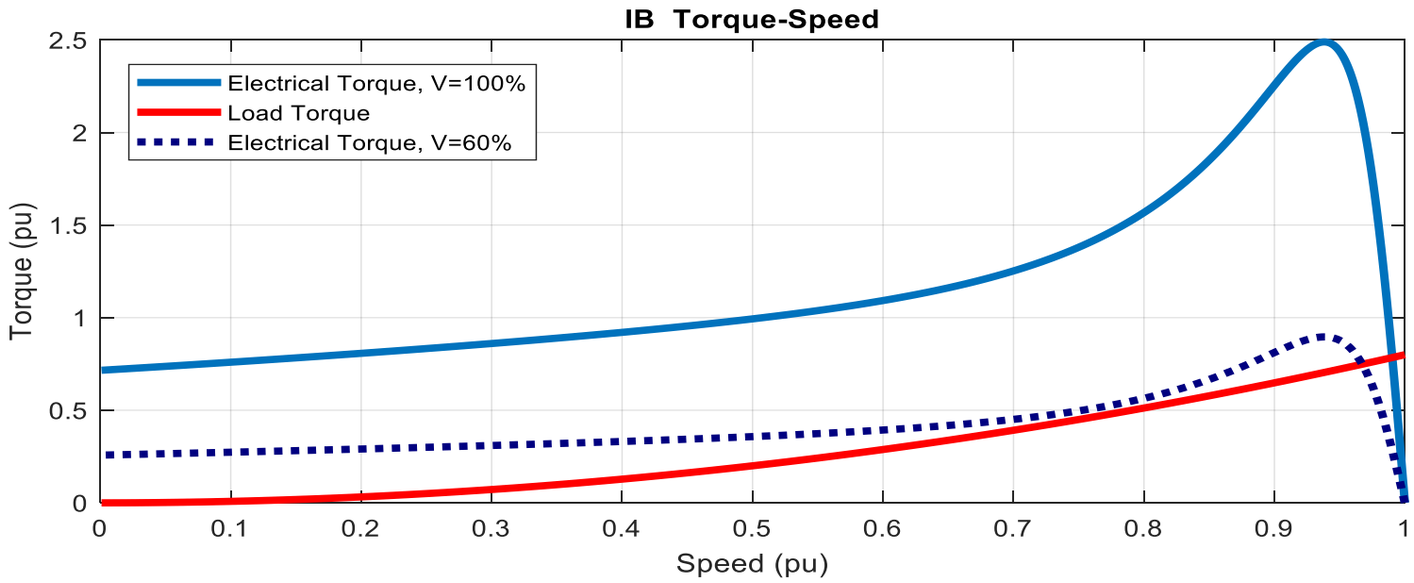
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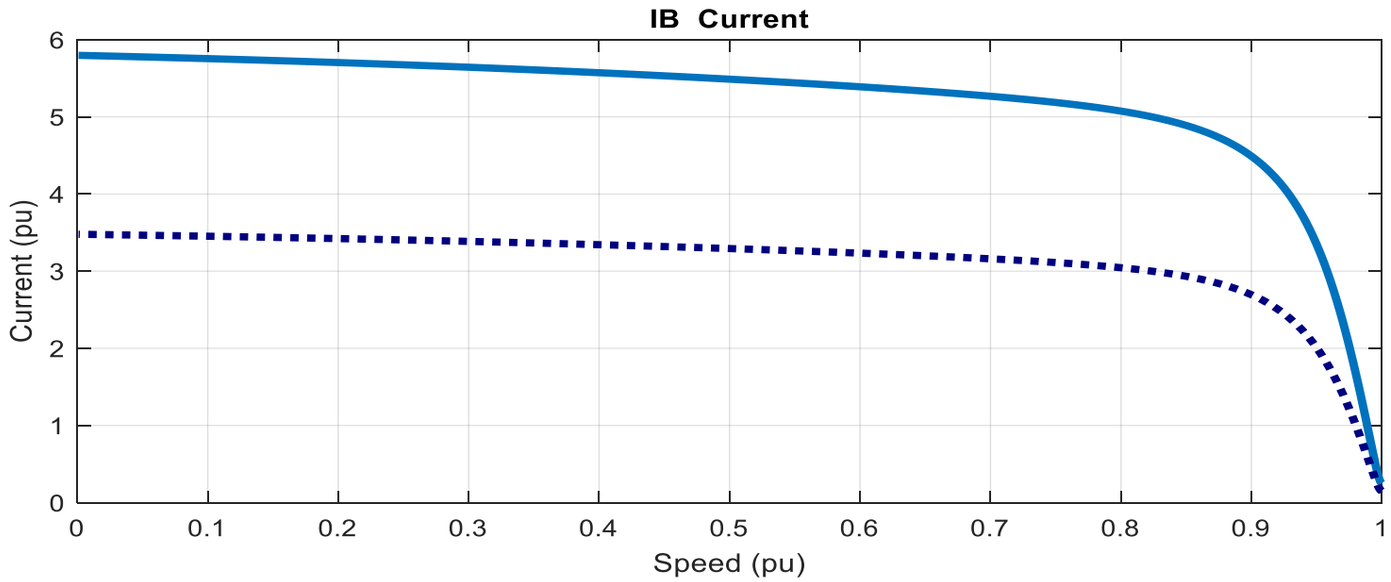
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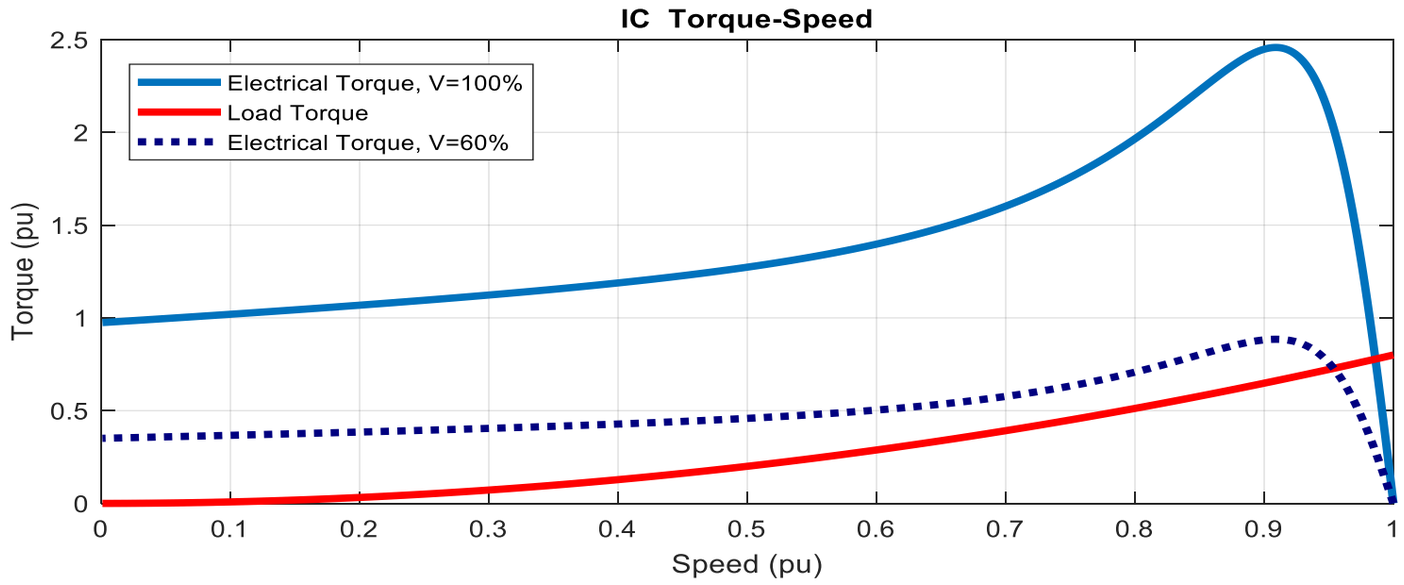
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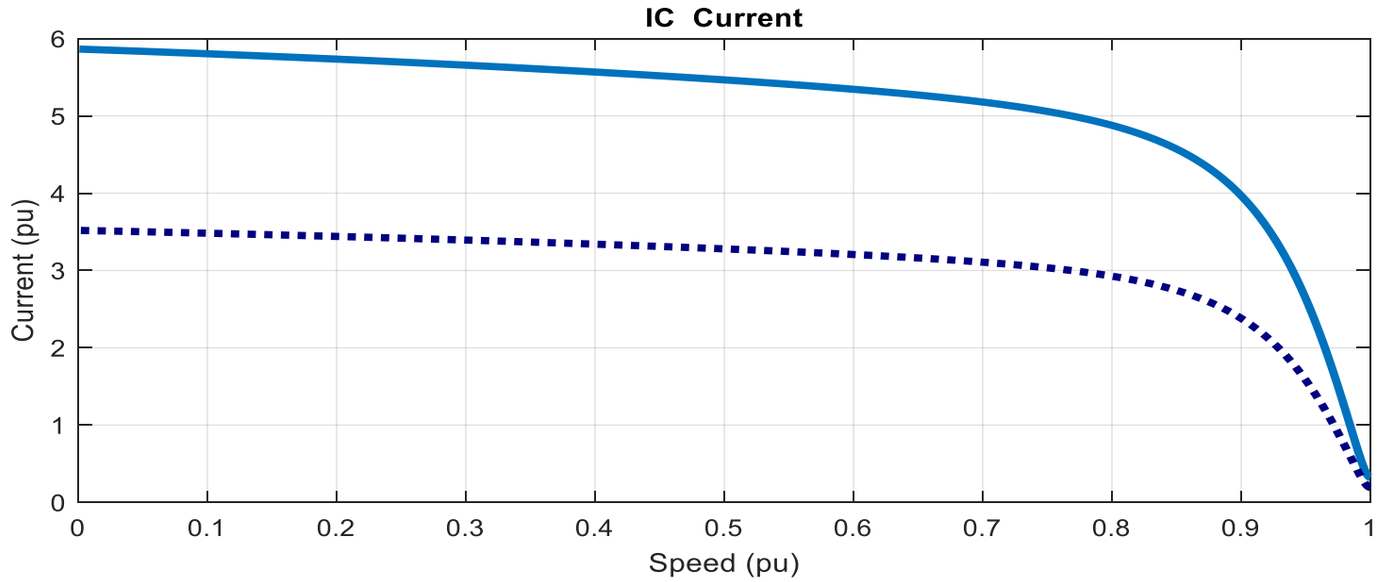
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Speed (pu)
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5
6
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0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

Motor Codes

NEMA Code	Starting Torque	CMPLDW Code
A	Normal	
B	High	IB, IC
C	High	
D	Very High	IA

Loads - Compressors

Load	Start Torque	Etrq	Example Application
Small - reciprocating	High	0	Corner body shop
Medium - recip	High	0	Air conditioning - big box store
Large - screw	Low	1	Large factory
Large - centrifugal	Low	1	Large air conditioning
V. Large compressor - centrif	Low	1	Pipeline/LNG/Reinjection

Loads - Fans / Blowers

Load	Start Torque	Etrq	Example Application
Small - medium speed	Low	1	Building services
Medium - high speed	Low	1	General industry
Large - low speed	Low	2	Cooling towers
Large - medium speed	Low	2	Factory exhausters

Loads - Pumps

Load	Start Torque	Etrq	Example Application
Small miscellaneous	Low	1	Drain pumps - building services
Medium	Low	1	Irrigation
Large	Low	1	Cooling water circulator
Medium positive displacement	High	1	Debarking

Loads - Miscellaneous

Load	Start Torque	Etrq	Example Application
Conveyor belt	Various	0	Quarry
Beam pump	High	0	Oilfield production
Down-well pump	Low	2	Irrigation / oilfield
Grinder/refiner	High	0	Paper mill
Ball mill	V. High	1	Mine

Loads - miscellaneous non-motor

Load	Characteristic	Example Application
Electrolysis	Constant I, P, ???	Aluminum production
Electrolysis	Constant I, P, ???	Chlorine production
Regulated DC	Constant VDC	Computer servers
Regulated AC	Highly variable	Traction

Loads - Combined cycle plant auxiliaries

Load	Start Torque	D	Example Application
Small fans / pumps	Low	1	Frame coolers, lubrication, drains
Medium fans / pumps	Low	1	Oil coolers
Large fans	Low	1	Condensers
Large pumps - hi speed	Low	1	Boiler feed pump
Large pumps - m speed	Low	1	Cooling circulators

Estimated load composition

Oil Production (IND_OIL)

MA (Beam Pumps):	30%
MB (Large Pumps, Fans and Compressors):	0%
MC (Small Pumps, Fans and Compressors):	40%
MD:	0%
Pwr El (drives):	30%
Const. Current (lighting):	0%
Resistive:	0%

Estimated load composition

Industrial Load Type	Code	IA	IB	IC	MD	PwrEl	Z	I
Petro-Chemical Plant	IND_PCH	0.1	0.4	0.3	0	0.15	0.02	0.03
Oil Pumping	IND_OIL	0.3	0	0.4	0	0.3	0	0
Shale Gas Extraction Plant	IND_SHG	0	0.2	0.4	0	0.4	0	0
Liquified Natural Gas	IND_LNG	0	0.3	0.2	0	0.5	0	0
Paper Mill, Kraft Process	IND_PMK	0.1	0.2	0.3	0	0.3	0.05	0.05
Paper Mill with Refiners	IND_PMT	0.05	0.6	0.15	0	0.15	0.02	0.03
Lumber Mill	IND_LMB	0.4	0.2	0.3	0	0	0.05	0.05
Mining	IND_MIN	0.25	0.25	0.3	0	0.2	0	0
Aluminum Smelter	IND_ASM	0.05	0	0.05	0	0.05	0.85	0
Steel Mill	IND_SML	0.15	0.35	0.25	0	0.15	0.05	0.05
Car Manufacturing	IND_CAR	0.15	0	0.3	0	0.3	0.1	0.15
Semiconductor	IND_SCD	0	0.25	0.3	0	0.4	0	0.05
Server Farm	IND_SRF	0	0	0.1	0	0.9	0	0
Industrial - Other	IND_OTH	0.1	0.3	0.3	0	0.2	0.05	0.05
Transportation - Rail	IND_RAIL	0	0	0.05	0	0.95	0	0
Power Plant Auxiliaries	PPA_AUX	0	0.4	0.3	0	0.2	0.05	0.05
Irrigation and pumping	AGR_IRR	0	0	1	0	0	0	0
Food processing	AGR_PRO	0.6	0	0.25	0	0.05	0.05	0.05

Thank you

Estimated load composition

Paper Mill – Kraft Process (IND_PMK)

MA (Recip. Compressors and Pumps):	10%	– agitators, conveyers
MB (Large Pumps, Fans and Compressors):	20%	
MC (Small Pumps, Fans and Compressors):	30%	
MD:	0%	
Pwr El (drives):	30%	
Const. Current (lighting):	5%	
Resistive:	5%	

Estimated load composition

Mining (IND_MIN)

MA (conveyers) :	25%
MB (Large Pumps, Fans and Compressors):	25%
MC (Small Pumps, Fans and Compressors)	30%
MD:	0%
Pwr El (drives):	20%
Const. Current (lighting):	0%
Resistive:	0%

Estimated load composition

Aluminum Smelter (IND_ASM)

MA (Recip. Compressors and Pumps):	5%
MB (Large Pumps, Fans and Compressors):	0%
MC (Small Pumps, Fans and Compressors)	5%
MD:	0%
Pwr El (drives):	5%
Const. Current (lighting):	0%
Resistive:	**85%**

Estimated load composition

Steel Mill (IND_SML)

MA (Recip. Compressors and Pumps):	15%
MB (Large Pumps, Fans and Compressors):	35%
MC (Small Pumps, Fans and Compressors):	25%
MD:	0%
Pwr El (drives):	15%
Const. Current (lighting):	5%
Resistive:	5%

Estimated load composition

Semiconductor Fab (IND_SCD)

MA (Recip. Compressors and Pumps):	0%
MB (Large Pumps, Fans and Compressors):	25%
MC (Small Pumps, Fans and Compressors):	30%
MD:	0%
Pwr El (drives):	40%
Const. Current (lighting):	5%
Resistive:	0%

Estimated load composition

Food Processing Plants (AGR_PRO)

MA (Recip. Compressors and Pumps):	60%
MB (Large Pumps, Fans and Compressors):	0%
MC (Small Pumps, Fans and Compressors):	25%
MD:	0%
Pwr El (computers):	5%
Const. Current (lighting):	5%
Resistive:	5%

https://aceee.org/files/proceedings/2001/data/papers/SS01_Panel1_Paper22.pdf

30

Estimated load composition

Industrial Load Type	Code	IA	IB	IC	MD	PwrEl	Z	I
Petro-Chemical Plant	IND_PCH	0.1	0.4	0.3	0	0.15	0.02	0.03
Oil Pumping	IND_OIL	0.3	0	0.4	0	0.3	0	0
Shale Gas Extraction Plant	IND_SHG	0	0.2	0.4	0	0.4	0	0
Liquified Natural Gas	IND_LNG	0	0.3	0.2	0	0.5	0	0
Paper Mill, Kraft Process	IND_PMK	0.1	0.2	0.3	0	0.3	0.05	0.05
Paper Mill with Refiners	IND_PMT	0.05	0.6	0.15	0	0.15	0.02	0.03
Lumber Mill	IND_LMB	0.4	0.2	0.3	0	0	0.05	0.05
Mining	IND_MIN	0.25	0.25	0.3	0	0.2	0	0
Aluminum Smelter	IND_ASM	0.05	0	0.05	0	0.05	0.85	0
Steel Mill	IND_SML	0.15	0.35	0.25	0	0.15	0.05	0.05
Car Manufacturing	IND_CAR	0.15	0	0.3	0	0.3	0.1	0.15
Semiconductor	IND_SCD	0	0.25	0.3	0	0.4	0	0.05
Server Farm	IND_SRF	0	0	0.1	0	0.9	0	0
Industrial - Other	IND_OTH	0.1	0.3	0.3	0	0.2	0.05	0.05
Transportation - Rail	IND_RAIL	0	0	0.05	0	0.95	0	0
Power Plant Auxiliaries	PPA_AUX	0	0.4	0.3	0	0.2	0.05	0.05
Irrigation and pumping	AGR_IRR	0	0	1	0	0	0	0
Food processing	AGR_PRO	0.6	0	0.25	0	0.05	0.05	0.05