Developing Key Quantities

Presented by
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Key Quantity Definition

A Key Quantity is a quantity, expressed in a defined unit of measure, that is associated with a cost element or discipline of an estimate.

For example:

- In construction for the process industries, the key quantity for concrete may be total cubic meters of concrete installed.
- In software development, the key quantity for the software programming cost element may be total lines of software code written or number of user interfaces developed.

Using Key Quantities

Key Quantities are typically discipline based in the process industries:

Key Quantities - Example

Discipline	U/M		Field MTO	Module MTO	Total MTO
Tree Clearing	Ha		83		**83**
Total Stripping Volume	M3		420000		**420000**
Excavation	M3		524000		**524000**
Backfill	M3		360400		**360400**
Gravel	M3		64500		**64500**
Overall Roads	M2		143000		**143000**
Piling	Ea		3590		**3590**
Concrete	M3		8750		**8750**
Equipment	EA		256		**256**
Steel	Ton		440	3210	**3650**
Architectural	M2		14829		**14829**
Piping	LM		12900	32500	**45400**
Insulation	LM		11440	27600	**39040**
Electrical (including EHT)	LM		469000	39800	**508800**
I&C (Instrument Tags)	Tags		1722		**1722**

Using Key Quantities

Key Quantities are typically based on CSI MasterFormat divisions in the commercial industries

CSI Div	Description	Takeoff Quantity	U/M
03.0	Concrete Work	13,653.37	CY
04.0	Masonry	15,240.00	SF
05.0	Metals	881.33	TN
07.0	Thermal & Moisture Protection	72,770.00	SF
08.0	Openings - Doors and Windows	54.00	EA
09.0	Finishes	72,770.00	SF
10.0	Specialties	42.00	EA
11.0	Equipment	8.00	EA
12.0	Furnishings	2.00	EA
13.0	Buildings Complete	1,862.00	SF
21.0	Fire Suppression	17,400.00	SF
22.0	Plumbing	17,400.00	SF
23.0	Heating, Ventilating, and Air Conditioning (HVAC)	17,400.00	SF
26.0	Electrical Work	225.00	EA
31.0	Earthwork	1,188,953.34	CY
32.0	Exterior Improvements	106,611.21	SY
33.0	Buried Piping	13,091.00	LF
33.5	Tank Construction	2,016,200.00	GAL
40.0	Process Piping	64,413.00	LF
40.9	Instrumentation & Controls	643.00	EA

Key Quantity Uses

Key quantities can be important for:

- Identifying the overall scope of a project.

How Do Key Quantities Identify Scope

Ensures the estimate reflects the stated project scope and should align with scope parameters.

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- Establishing estimate metrics for the purposes of estimate validation against historical benchmarks.

Key Quantities Used for Benchmark

- Identifies major quantity variances to the baseline (or benchmark)
- Exposes potential high risk areas of the project

Description	Quantity		Variance to Benchmark Average	Variance to Benchmark Median	Average		Median		Low		High	
					Quantity		Quantity		Quantity		Quantity	
Piles	3,844	EA	40.5%	50.4%	2,735	EA	2,556	EA	2,154	EA	3,674	EA
Concrete	8,522	CM	11.6%	17.5%	7,633	CM	7,252	CM	6,740	CM	9,288	CM
Structural Steel	9,365	MT	209.7%	221.9%	3,024	MT	2,910	MT	2,303	MT	3,975	MT
Piping	42,888	LM	-23.8%	-19.5%	56,298	LM	53,265	LM	41,915	LM	76,745	LM
Electrical (Wire/Cable/Tracing)	321,488	LM	16.3%	29.6%	276,324	LM	248,053	LM	213,860	LM	344,802	LM
Insulation (Pipe Insulation)	38,445	LM	-12.7%	-11.2%	44,041	LM	43,280	LM	39,626	LM	49,977	LM

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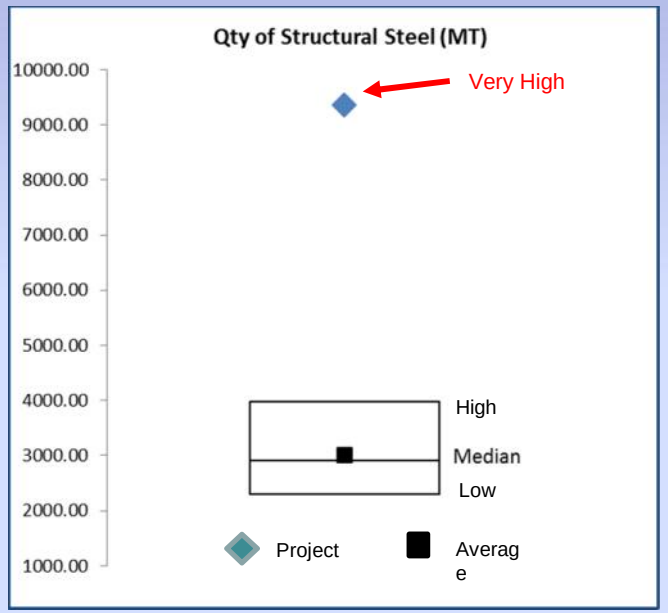
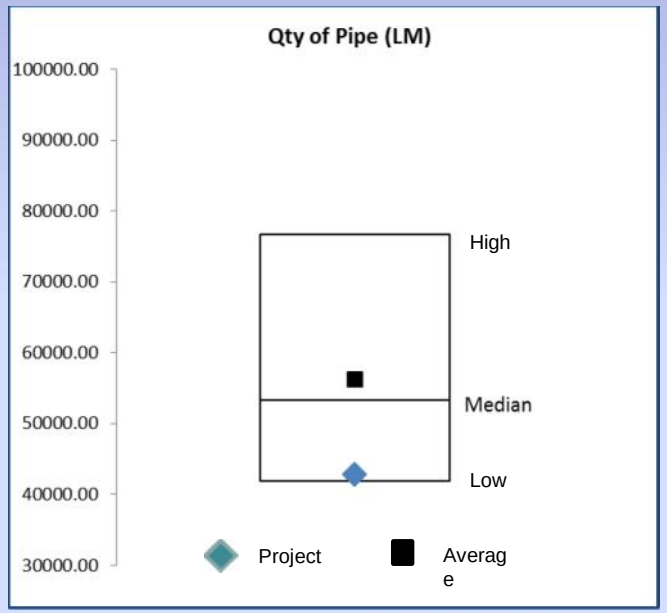
Key Quantities Used for Benchmarking

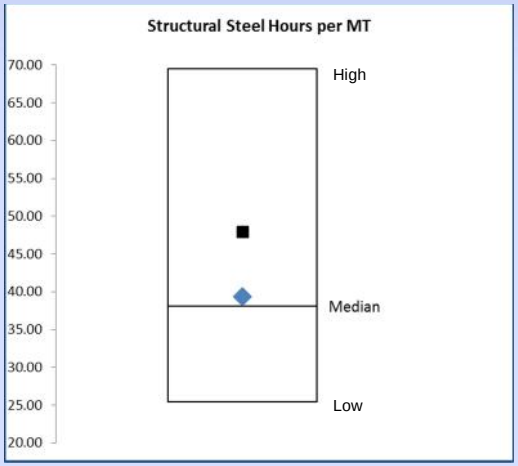


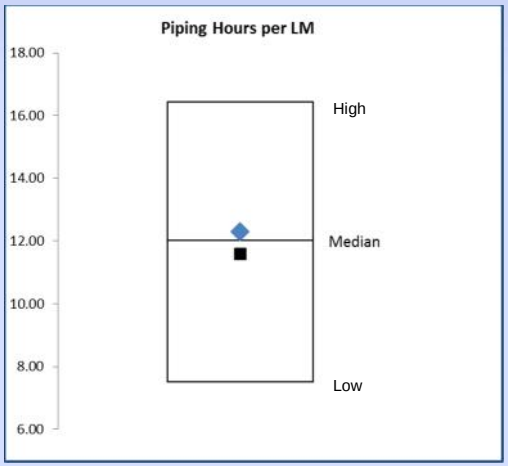


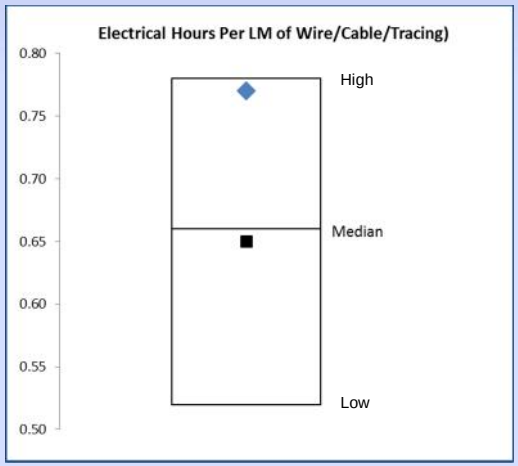
Key Quantities Used for Benchmarking

Examine discipline variances to the baseline using Key Quantities

Description	Quantity		Total Hour	Hours per Unit		Variance to Benchmark Average	Variance to Benchmark Median	Average		Median		Low		High	
								Hours per Unit		Hours per Unit		Hours per Unit		Hours per Unit	
Structural Steel	9,365	MT	368787	39.38	MT	-17.9%	3.3%	47.96	MT	38.14	MT	25.46	MT	69.47	MT
Piping	42,888	LM	527094	12.29	LM	6.0%	2.3%	11.59	LM	12.01	LM	7.51	LM	16.43	LM
Electrical	321,488	LM	247546	0.77	LM	18.5%	16.7%	0.65	LM	0.66	LM	0.52	LM	0.78	LM







Key Quantities Used for Benchmarking

Examine material cost variances to the baseline

Description	Quantity		Total Material Cost	Cost per Unit		Variance to Benchmark Average	Variance to Benchmark Median	Average Cost per Unit		Median Cost per Unit		Low Cost per Unit		High Cost per Unit	
Piling	3,844	EA	12,373,836	3,219.00	EA	-7.4%	-5.0%	3,477.00	EA	3,388.00	EA	1,940.00	EA	5,195.00	EA
Concrete	8,522	CM	7,951,026	933.00	CM	0.3%	-1.3%	930.00	CM	945.00	CM	801.00	CM	1,043.00	CM
Structural Steel	9,365	MT	37,618,482	4,017.00	MT	-1.7%	5.7%	4,085.00	MT	3,800.00	MT	3,423.00	MT	5,115.00	MT
Piping	42,888	LM	13,831,380	322.50	LM	-16.2%	-11.2%	385.00	LM	363.00	LM	289.00	LM	487.00	LM
Electrical	321,488	LM	18,369,824	57.14	LM	1.8%	-1.8%	56.13	LM	58.17	LM	35.59	LM	80.74	LM

Key Quantities Used for Benchmarking

When benchmarking with Key Quantities, to ensure valid comparisons, the source projects that supply the key quantity data must be:

- Classified by type
- Classified by Size
- Key Quantity Categories must be uniformly defined

Key Quantity Uses

Key quantities can be important for:

- Identifying the overall scope of a project.
- Establishing estimate metrics for the purposes of estimate validation against historical benchmarks.
- Establishing discipline based quantities for the purposes of estimate comparison and reconciliation.

Using Key Quantities for Reconciliation

Key Quantities can be used to compare different classes of estimates

- Identifies major quantity variances as the project matures
- Expose potential scope creep

Description	U/M	Quantity Class 4	Quantiy Class 3	Quantity Variance Class 3 to Class 4	Percent Variance Class 3 to Class 4
Piles	EA	1956	3844	1,888	96.5%
Concrete	CM	7868	8522	654	8.3%
Structural Steel	MT	5955	9364.82	3,410	57.3%
Piping	LM	51010	42888	-8,122	-15.9%
Electrical (Wire/Cable/Tracing)	LM	289400	321488	32,088	11.1%
Insulation (Pipe Insulation)	LM	36541	38445	1,904	5.2%

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Using Key Quantities for Reconciliation

Key Quantities can be used to compare owner to contractor estimates

		Owner				Contractor				Owner minus Contractor		
Discipline	**U/M**	**Field MTO**	**Mod MTO**	**Total MTO**	**Field to Mod Ratio**	**Field MTO**	**Mod MTO**	**Total MTO**	**Field to Mod Ratio**	**Field MTO**	**Mod MTO**	**Total MTO**
Tree Clearing	Ha	83		**83**						83	0	**83**
Total stripping volume	M3	420000		**420000**						420000	0	**420000**
Excavation	M3	524000		**524000**						524000	0	**524000**
Backfill	M3	360400		**360400**						360400	0	**360400**
Gravel	M3	64500		**64500**						64500	0	**64500**
Overall Roads	M2	143000		**143000**						143000	0	**143000**
Piling	Ea	3590		**3590**		3939		**3939**		-349	0	**-349**
Concrete	M3	8750		**8750**		10034		**10034**		-1284	0	**-1284**
Fireproofing	M3	256		**256**						256	0	**256**
Steel	Ton	440	3210	**3650**	**0.14**	534	3882	**4416**	**0.14**	-94	-672	**-766**
Architectural	M2	14829		**14829**		18548		**18548**		-3719	0	**-3719**
Piping	LM	12900	32500	**45400**	**0.40**	20600	48707	**69307**	**0.42**	-7700	-16207	**-23907**
Insulation	LM	11440	27600	**39040**	**0.41**					11440	27600	**39040**
Electrical (includes EHT)	LM	469000	39800	**508800**	**11.78**	608142	95076	**703218**	**6.40**	-139142	-55276	**-194418**
I&C (Instrument Tags)	Tags	1722		**1722**		2600		**2600**		-878	0	**-878**

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Discipline	**U/M**	**Field MTO**	**Mod MTO**	**Total MTO**	**Field to Mod Ratio**	**Field MTO**	**Mod MTO**	**Total MTO**	**Field to Mod Ratio**	**Field MTO**	**Mod MTO**	**Total MTO**
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Piling	Ea	3590		**3590**		3939		**3939**		-349	0	**-349**
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Using Key Quantities for Reconciliation

Key Quantities can be used during the execution phase of a project to make high level bid comparisons

		Field Quantities			Module Quantities			Total Quantities		
Discipline	**U/M**	**Bidder A**	**Bidder B**	**Low Bidder**	**Bidder A**	**Bidder B**	**Low Bidder**	**Bidder A**	**Bidder B**	**Low Bidder**
Tree Clearing	Ha	83	87	**Bidder A**				83	87	**Bidder A**
Total stripping volume	M3	420000	615000	**Bidder A**				420000	615000	**Bidder A**
Excavation	M3	524000	712000	**Bidder A**				524000	712000	**Bidder A**
Backfill	M3	360400	383000	**Bidder A**				360400	383000	**Bidder A**
Gravel	M3	64500	52500	**Bidder B**				64500	52500	**Bidder B**
Overall Roads	M2	143000	138000	**Bidder B**				143000	138000	**Bidder B**
Piling	Ea	3590	3572	**Bidder B**				3590	3572	**Bidder B**
Concrete	M3	8750	9100	**Bidder A**				8750	9100	**Bidder A**
Fireproofing	M3	256	195	**Bidder B**				256	195	**Bidder B**
Steel	Ton	440	425	**Bidder B**	4250	3882	**Bidder B**	4690	4307	**Bidder B**
Architectural	M2	14829	15245	**Bidder A**	2600	1420	**Bidder B**	17429	16665	**Bidder B**
Piping	LM	12900	18400	**Bidder A**	44580	38710	**Bidder B**	57480	57110	**Bidder B**
Insulation	LM	11440	16900	**Bidder A**	28500	31250	**Bidder A**	39940	48150	**Bidder A**
Electrical (includes EHT)	LM	469000	352000	**Bidder B**	41500	95076	**Bidder A**	510500	447076	**Bidder B**
I&C (Instrument Tags)	Tags	1251	1390	**Bidder A**	482	343	**Bidder B**	1733	1733	**Bidder B**

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- Identifying the overall scope of a project.
- Establishing estimate metrics for the purposes of estimate validation against historical benchmarks.
- Establishing discipline based quantities for the purposes of estimate comparison and reconciliation.
- High level progress management.

Key Quantities Used for Progress Management

High level progress measurement during project execution

Item Description	Unit	Base Quantity (Key Qty)	Change Order Quantity	Revised Quantity (Key Qty)	Actual Quantity Installed	Balance to Install	Percent Complete	Reported Percent Complete	Estimated Qty's at Completion	Quantity Over or Underrun
						Based on Actual Installed		Based on Reported Complete		
Piling	EA	3,606	55	3,661	3,569	92	97.5%	100.0%	3,569	-92
Earthwork	CM	989,500	-180,400	809,100	812,000	(2,900)	100.4%	85.0%	933,365	124,265
Concrete	CM	9,350	0	9,350	9,340	10	99.9%	95.0%	9,808	458
Steel	MT	1,469	450	1,919	1,480	439	77.1%	75.0%	1,960	41
Buildings	EA	29	0	29	21	8	72.4%	70.0%	30	1
Equipment	EA	177	21	198	147	51	74.2%	80.0%	187	-11
Piping	LM	38,844	2,450	41,294	32,480	8,814	78.7%	70.0%	44,868	3,574
Electrical	LM	478,792	-54,000	424,792	210,000	214,792	49.4%	50.0%	422,396	-2,396
Instrumentation	EA	1,612	0	1,612	755	857	46.8%	40.0%	1,722	110
Painting	SM			0		0			0	0
Insulation	LM	36,958	2,150	39,108	19,450	19,658	49.7%	50.0%	39,004	-104
Scaffolding	MT	55	13	68	72	(4)	105.9%	90.0%	79	11

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Steel	MT	1,469	450	1,919	1,480	439	77.1%	75.0%	1,960	41
Buildings	EA	29	0	29	21	8	72.4%	70.0%	30	1
Equipment	EA	177	21	198	147	51	74.2%	80.0%	187	-11
Piping	LM	38,844	2,450	41,294	32,480	8,814	78.7%	70.0%	44,868	3,574
Electrical	LM	478,792	-54,000	424,792	210,000	214,792	49.4%	50.0%	422,396	-2,396
Instrumentation	EA	1,612	0	1,612	755	857	46.8%	40.0%	1,722	110
Painting	SM			0		0			0	0
Insulation	LM	36,958	2,150	39,108	19,450	19,658	49.7%	50.0%	39,004	-104
Scaffolding	MT	55	13	68	72	(4)	105.9%	90.0%	79	11

Key Quantities Used for Progress Management

High level progress measurement during project execution

Item Description	Unit	Base Quantity (Key Qty)	Change Order Quantity	Revised Quantity (Key Qty)	Actual Quantity Installed	Balance to Install	Percent Complete	Reported Percent Complete	Estimated Qty's at Completion	Quantity Over or Underrun
						Based on Actual Installed		Based on Reported Complete		
Piling	EA	3,606	55	3,661	3,569	92	97.5%	100.0%	3,569	-92
Earthwork	CM	989,500	-180,400	809,100	812,000	(2,900)	100.4%	85.0%	933,365	124,265
Concrete	CM	9,350	0	9,350	9,340	10	99.9%	95.0%	9,808	458
Steel	MT	1,469	450	1,919	1,480	439	77.1%	75.0%	1,960	41
Buildings	EA	29	0	29	21	8	72.4%	70.0%	30	1
Equipment	EA	177	21	198	147	51	74.2%	80.0%	187	-11
Piping	LM	38,844	2,450	41,294	32,480	8,814	78.7%	70.0%	44,868	3,574
Electrical	LM	478,792	-54,000	424,792	210,000	214,792	49.4%	50.0%	422,396	-2,396
Instrumentation	EA	1,612	0	1,612	755	857	46.8%	40.0%	1,722	110
Painting	SM			0		0			0	0
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Scaffolding	MT	55	13	68	72	(4)	105.9%	90.0%	79	11

Key Quantity Basis for Construction Industries

- Key quantities are typically discipline based regardless of the industry
  - Commercial – Hotels, Hospitals, Schools, Office Buildings, Etc.
  - Infrastructure – Utilities, Roadways, Pipelines, etc.
  - Process Industries – Manufacturing, Chemicals, Oil and Gas, etc.
- Estimate summaries are unique by industry
- Disciplines in different industries may use different commodities to identify their key quantities

Key Quantity Units - Defined

Example of possible commodity based key quantity unit definitions per discipline by industry

Discipline	Commercial	Unit	Infrastructure	Unit	Process Industries	Unit
Piling	Installed Piles	EA	Installed Piles	EA	Installed Piles	EA
Earthwork	Excavated Earth	CM	Excavated Earth	CM	Excavated Earth	CM
Roadways	Surface Area of Roadway	SM	Length of 4 LM Wide Roadway	KM		
Concrete	Total CIP Concrete	CM	Total CIP Concrete	CM	Total CIP Concrete	CM
Steel	Installed Structural Steel	MT	Installed Steel	MT	Installed Steel	MT
Buildings			Installed Buildings	EA	Installed Buildings	EA
Equipment	Installed Pieces of Equipment	EA	Installed Pieces of Equipment	EA	Installed Pieces of Equipment	EA
Piping	Installed Large Bore Pipe	LM	Installed Large Bore Pipe	LM	Installed Large Bore Pipe	LM
Electrical	Installed Wire and Cable	LM	Installed Wire and Cable	LM	Installed Wire and Cable	LM
Instrumentation	Installed Instruments	EA	Installed Instruments	EA	Installed Instruments	EA
Painting	Surface Area	SM	Surface Area	SM	Surface Area	SM
Insulation	Length of Pipe with Insulation	LM	Length of Pipe with Insulation	LM	Length of Pipe with Insulation	LM

Key Quantity Descriptions – O&G Projects

Uniform descriptions are crucial to ensure meaningful comparisons

Key Quantity Descriptions

Item Description	Unit	Key Quantity Description
Piling	EA	all piles regardless of type and size
Earthwork	CM	all excavated earthwork including roadways associated with the facility
Concrete	CM	installed CIP concrete only
Steel	MT	all structural steel
Buildings	EA	all buildings including modular and stick built
Equipment	EA	all pieces of equipment (packages count as 1)
Piping	LM	all sizes of pipe installed above and below ground
Electrical	LM	all wire and cable including electrical heat trace
Instrumentation	EA	all installed instruments (does not include gages or valves)
Painting	SM	area of all painted surfaces
Insulation	LM	all insulated pipe (does not include insulated equipement)
Scaffolding	Lot	unidentified

Key Quantity Descriptions – O&G Projects

Uniform descriptions are crucial to ensure meaningful comparisons

Key Quantity Descriptions

Item Description	Unit	Key Quantity Description
Piling	EA	all piles regardless of type and size
Earthwork	CM	all excavated earthwork including roadways associated with the facility
Concrete	CM	installed CIP concrete only
Steel	MT	all structural steel
Buildings	EA	all buildings including modular and stick built
Equipment	EA	all pieces of equipment (packages count as 1)
Piping	LM	all sizes of pipe installed above and below ground
Electrical	LM	all wire and cable including electrical heat trace
Instrumentation	EA	all installed instruments (does not include gages or valves)
Painting	SM	area of all painted surfaces
Insulation	LM	all insulated pipe (does not include insulated equipement)
Scaffolding	Lot	unidentified

Key Quantity Descriptions – O&G Projects

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Key Quantity Descriptions

Item Description	Unit	Key Quantity Description
Piling	EA	all piles regardless of type and size
Earthwork	CM	all excavated earthwork including roadways associated with the facility
Concrete	CM	installed CIP concrete only
Steel	MT	all structural steel
Buildings	EA	all buildings including modular and stick built
Equipment	EA	all pieces of equipment (packages count as 1)
Piping	LM	all sizes of pipe installed above and below ground
Electrical	EA	all power consuming devices
Instrumentation	EA	all installed instruments (does not include gages or valves)
Painting	SM	area of all painted surfaces
Insulation	LM	all insulated pipe (does not include insulated equipement)
Scaffolding	Lot	unidentified

Conclusion

Key Quantities are:

- Defined as a quantity, expressed in a defined unit of measure, that is associated with a cost element or discipline of an estimate.
- Used for scope verification, benchmarking, estimate validation, estimate reconciliation, and high level progress measurement
- Typically discipline based but have unique commodity based units on measure depending on the industry

Any Questions?

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