

Process Model

Name MEP Quantity Take Off

Identifier xxx

Change Log
2008-08-01

Created

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Exchange Requirements

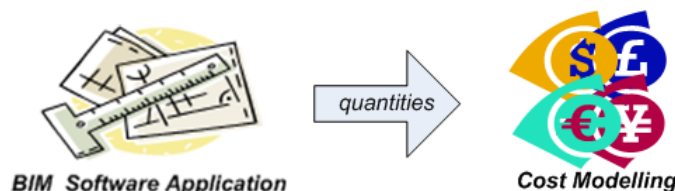
er_exchange_MEP_QTO (order_of_magnitude)
er_exchange_MEP_QTO (preliminary_quantities)
er_exchange_MEP_QTO (approximate_quantities)
er_exchange_MEP_QTO (preconstruction_quantities)

Overview

This process map document is about determining quantities of materials used, or expected to be used, in mechanical electrical and plumbing (public health) or MEP engineering installations.

Quantity take off is considered to be the process that determines the quantity of materials that are to 'measured' at a point in time. Typically, that purpose is a stage within a cost planning process. Unit costs can then be applied to the quantities to provide an assessment of cost at that stage.

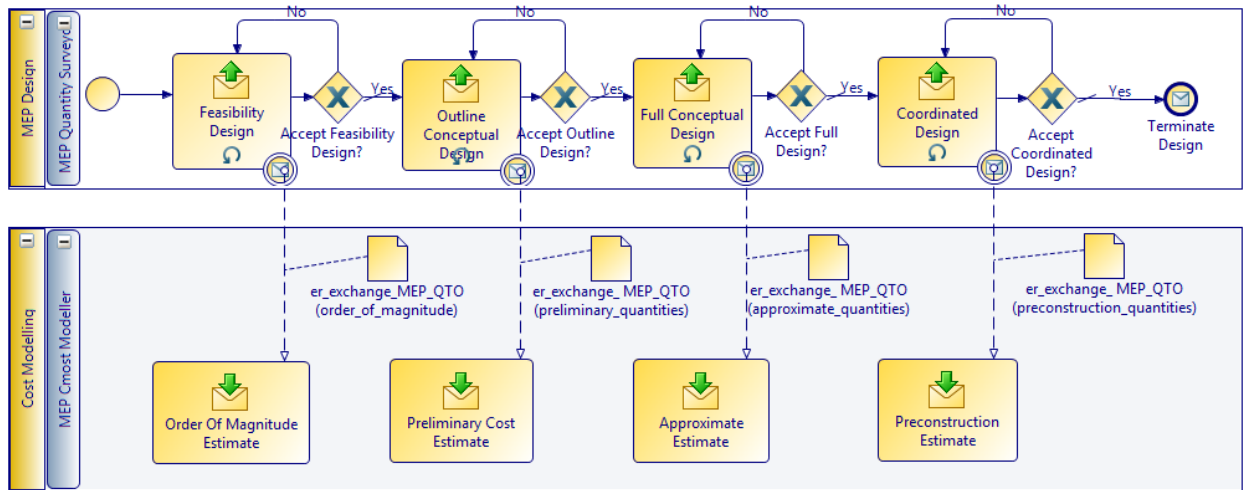
The purpose of separating the idea of quantities from the idea of cost is to allow for quantities to be determined by one actor (or group of actors) and the costs to be applied by a second actor (or group of actors) . Practically, this allows for quantities to be assigned within one software application (e.g. a geometrically driven Building Information Model) and then costed within a second application (cost modelling/cost estimating)



The determination of quantities is undertaken progressively throughout the design and construction of a project and makes use of the information that is available at the time. It starts at the earliest stage when information may be available only about the type of building required together with its expected overall size and location. As more detail is added to the design, quantity measurement can be refined based on area measurement of spaces until estimates can be developed based on complete knowledge of the elements to be incorporated within the project.

Four work stages stages are considered for the purposes of MEP quantity takeoff. These are shown below with the quantity/cost type at a stage mapped to a more typical expression of the design stage.

<i>CP Stage</i>	<i>Name</i>		<i>Project Stage</i>	<i>Name</i>
1	Order of Magnitude	→	2	Outline Feasibility
			3	Substantive Feasibility
2	Preliminary Quantities	→	4	Outline conceptual design
3	Approximate Quantities	→	5	Full conceptual design
4	Preconstruction Quantities	→	6	Coordinated design and procurement

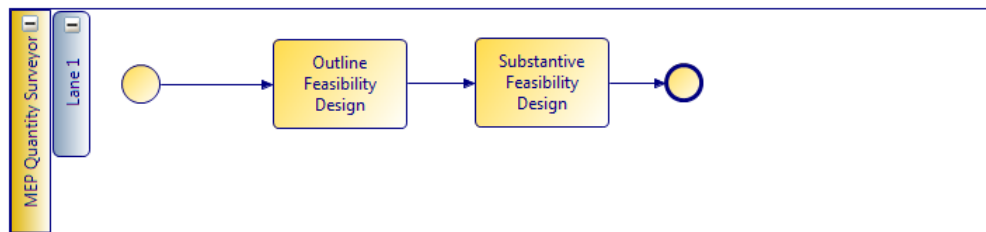


Specification of Processes

Feasibility Design [ID:1]

Type	Sub-process (collapsed) Send Task (Transaction)
Name	Feasibility Design
Documentation	<p>Feasibility Design incorporates the sub-process 'outline feasibility design' and substantive feasibility design'. In both cases, the assessment of quantities is considered to be at the order of magnitude level.</p> <p>At feasibility, design information may be available only as a series of requirements that indicate the intended purpose, size and content of the building. It may be possible through the requirements of the building to establish areas to be serviced, types of services to be provided and possibly, for some key entities, approximate numbers expected.</p>

Feasibility design is a collapsed sub-process that combines the outline and substantive feasibility design stages.



Outline Conceptual Design [ID:2]

Type	Task Send Task (Transaction)
Name	Outline Conceptual Design
Documentation	<p>At outline conceptual design, it is expected that spaces within the building will have been laid out so that area information is available down to the level of the individual space. This should also include all circulation spaces. It is also expected that all spaces will have been identified in terms of their name and purpose according to whatever naming conventions/classifications are in place for this.</p> <p>It is also expected that all requirements will have been provided so that key distribution elements within spaces are identified. The provision of requirements information should be enough to assess numbers of items in a space and to allow an estimate of overall loadings to be made so that size of major plant can be assessed.</p>

Full Conceptual Design [ID:3]

Type	Task Send Task (Transaction)
Name	Full Conceptual Design
Documentation	<p>At full conceptual design, it is expected that all of the systems will have been designed and that initial modelling will have been done. This includes the sizing of systems so that the MEP quantity surveyor can determine how much of each size of flow segment is required.</p> <p>From an MEP perspective, it is at this stage that there should be sufficient information available to enable quantities to be assessed in terms of the systematic provision (i.e. by counting what is there) rather than their spatial performance.</p>

Coordinated Design [ID:4]

Type	Task Send Task (Transaction)
Name	Coordinated Design
Documentation	<p>All systems will be fully designed, detailed and modelled for coordinated design. The only thing that may be missing from the design is the precise manufacturer specification of some components, particularly if the the installation / construction work is to be determined by a contractors final decision.</p> <p>Coordinated design includes all other specified requirements including both quality and performance. The MEP quantity surveyor can, depending on what information is considered necessary, determine both actual and measured lengths of flow segments, their coverings and builders work requirements, together with all fitting, fixing, carrying and waste provisions.</p> <p>Coordinated design should enable the MEP quantity surveyor and designers to obtain quantity information necessary for tendering and procurement, scheduling, delivery and prefabrication, asset management, maintenance and other purposes.</p>

Order Of Magnitude Estimate [ID:5]

Type	Task Receive Task (Transaction)
Name	Order Of Magnitude Estimate
Documentation	Assigns costs to quantities. Refer to exchange requirements for cost models for further detail.

Preliminary Estimate [ID:6]

Type	Task Receive Task (Transaction)
Name	Preliminary Cost Estimate
Documentation	Assigns costs to quantities. Refer to exchange requirements for cost models for further detail.

Approximate Estimate [ID:7]

Type	Task Receive Task (Transaction)
Name	Approximate Estimate
Documentation	Assigns costs to quantities. Refer to exchange requirements for cost models for further detail.

Preconstruction Estimate [ID:8]

Type	Task Receive Task (Transaction)
Name	Preconstruction Estimate
Documentation	Assigns costs to quantities. Refer to exchange requirements for cost models for

	further detail.
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Specification of Data Objects

Exchange Requirement Data Objects

er_exchange_MEP_QTO (order_of_magnitude) [ID:1]

Type	Data Object
Name	er_exchange_MEP_QTO (order_of_magnitude)
Documentation	<p>For feasibility, it is expected that area quantities will be the primary information available and that this will be in terms of major functional areas and possibly spaces if requirements (through briefing space programming) are already established.</p> <p>This information is relevant for downstream cost calculations that will most probably use historical information.</p> <p>The method of measurement for the quantities should be determined. At this stage, it is unlikely to be a rule based method but based on a general measurement of the building / building story shapes. In the absence of an industry standard classification, it is probable that an organization specific classification will be used.</p> <p>Building information in terms of its purpose/use group should be classified. Building information should include whether it is a new project or a refurbishment.</p> <p>Major items of plant and equipment may be identified (either specifically or in general terms) and some indication of the performance of such items established.</p> <p>Quantities are determined from expected major cost breakdowns for the project or, if this is not available, by the primary system types expected to be included within the project.</p> <p>Specific information required at this stage includes:</p> <ul style="list-style-type: none"> • the project for which quantities are to be determined shall be identified (name); • the units generally used throughout the project shall be set; • a building shall be identified; <ul style="list-style-type: none"> • it should be of a particular type or perform a particular function (several functions may be identified within a particular type); • it should be located in a particular place and on a particular site (several alternative locations may be identified; each location should be dealt with individually); • it has an estimated overall area and/or volume requirement OR it is related by a size factor to a similar previous project about which information is known; • there are factors that affect the 'order of magnitude' quantities for MEP including (but not limited to) items shown below; those that will have an impact on the quantities should be determined; <ul style="list-style-type: none"> • expected building configuration (e.g. multi-storey as opposed to single storey); • expected heights of spaces or storeys where it is expected that these will be significantly higher than normal; • expected level of servicing for operational and comfort purposes; • accessibility of the location;

	<ul style="list-style-type: none"> • labor resource availability; • the method of measurement to be used for determination of quantities shall be specified; • classification to be used should be determined and applied., particularly for classification of objects for collection into groups and assemblies for costing purposes;
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Exchange_MEP_QTO (Preliminary_Quantities) [ID:1]

Type	Data Object
Name	Exchange_MEP_QTO (Preliminary_Quantities)
Documentation	<p>Preliminary quantities determined will be based on the type of element being considered. For some elements, quantities may be assessed by area (for instance, expected number of light fittings per square meter in office spaces). However, quantities for other elements may be based on counting the number expected. The precise method of quantification at this stage is entirely dependent on the way in which historical data is recorded and maintained (whether this is through a public service or whether it is recorded and maintained by a company locally).</p> <p>The method of measurement for the quantities should be determined. At this stage, it may be a rule based method for areas but there are unlikely to be specific measurement rules for counting objects.</p> <p>Classification systems should be selected for classifying elements. This includes both the spaces used for area quantification and the elements that are counted. This is relevant for later quantity breakdowns which may be at a further level of decomposition of the information at outline conceptual design.</p> <p>For pipework and ductwork, the number of 'terminals' that may be located on a system may be used with appropriate factors. For some systems these may be flow terminals; for other systems, the terminal may be a different entity (e.g. a waste outlet or a sanitary element). Where rules/factors can be established that relate a number of units to a length of flow segment, then linear quantities can be established. Rules/factors should be varied according to building type, density of servicing, building usage, overall building shape, number of vertical risers and more.</p> <p>For electrical systems, using numbers of switches and loads and then allowing a cable length per switch or load can deliver quantities. From this, an expected value of cable carriers (conduit, tray, trunking, ladder) can be assessed.</p> <p>With linear values established, initial assessments can also be made of delivery quantities and a view taken on the logistics of delivery to site and required storage space. For ductwork and pipework, this may also include making assessments of delivery weights.</p> <p>Particular information that is required to determine 'preliminary quantities' includes:</p> <ul style="list-style-type: none"> • a building is defined in terms of its shape and the number of building storeys that it contains (or is expected to contain) • it should be located in a particular place and on a particular site • there are factors that affect the 'preliminary appraisal' quantities including (but not limited to) items such as <ul style="list-style-type: none"> - expected building configuration (e.g. multi-storey as opposed to single storey) - expected level of servicing for operational and comfort purposes

	<ul style="list-style-type: none"> - accessibility of the location - labor resource availability <ul style="list-style-type: none"> • the name of the project (for identification purposes) and the units generally used throughout the project; • the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement • the location the site on which the building is to be located • the building storeys within the building together with their area (although the shape representation of a building storey is not necessary for this Exchange Requirement) • the area, volume or size factor of the building • classification of objects quantified
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Exchange_MEP_QTO (Approximate_Quantities) [ID:1]

Type	Data Object
Name	Exchange_MEP_QTO (Approximate_Quantities)
Documentation	<p>This exchange requirement assumes that a full conceptual building model has been defined and that relevant information can be obtained from shape representations that it contains. The full conceptual model provides sufficient detail to enable the extraction of information to enable the approximate quantities to be derived. For instance, in defining a system group for a heating system, the group should contain all of the heat emitters within the system</p> <p>Approximate quantities determined will be based on a model of the systems layout. Since the model is expected to include lengths, sizes and elevations of the flow elements, it is expected that all quantities from this stage onwards are based on a measure of actual elements and not by a historical performance criterion.</p> <p>It is not necessarily expected however that systems will be fully detailed at this stage. Smaller elements and additions to systems such as air vents, drains, measuring points and instrumentation etc. are likely to be not yet included.</p> <p>The method of measurement for the quantities should be determined. This will include determining the approach to be used for determining the overall length of flow segments used (pipework, cable or ducting and how to estimate fittings used.</p> <p>Classification systems should be selected for classifying elements. This includes both the spaces used for area quantification and the elements that are counted. This is relevant for later quantity breakdowns which may be at a further level of decomposition of the information at outline conceptual design.</p> <p>Pipework should be set out so that quantities of flow segments at different elevations (below floor, low level, high level and above ceiling) can be found. Once this is established, the following additional quantities can also be determined.</p> <p>1) By considering the configuration of systems (complexity, density etc.), an allowance of additional length quantity of pipework could be made so that it is not necessary to actually count how many of each type of fitting is required</p> <p>2) The total number of fittings may be counted but rather than counting each individual type, they may be expressed in terms of a 'counted fitting' (the term used to identify the idea of a hybrid fitting consisting of j% elbow, k% tee, m% union, n% bend may vary between places)</p> <p>3) Counted fittings could be quantified at this stage as being some number per 100m of pipework (e.g. 30 counted fittings per 100m). This is an alternative to adding a</p>

	<p>length but may be easier than doing an actual fitting count. It has the advantage that it preserves the idea of fittings within a quantity set.</p> <p>4) Allowances can be made for fixing (hangers and brackets). Typically however, fixing allowances are made when costing. It could be done by making a length allowance to the pipework but this might later distort any quantity take off used for ordering purposes.</p> <p>5) Weight quantities can be assessed either by system or overall.</p> <p>6) Because pipe sizes, lengths and elevations are known, labor estimates could also be made in terms of time quantities so that an overall assessment of labour requirement can be made. This is valuable since it facilitates the assessment of local labor availability and/or potential travelling requirements</p> <p>For ductwork. schedules of flow segments can be determined by length. Flow segments of particular sizes use particular thicknesses of materials in their manufacture and this can give an idea of overall weight. This is relevant since, at this stage, it is common for ductwork costing to be assessed by the weight of material used.</p> <p>For electrical installations, it is expected at this stage that main distribution cables between distribution boards should be able to be determined by length. However, cabling for final circuits is probably still based on a length assessment by counting runouts to switches, outlets and final loads and then allowing an expected length per runout. However, it is expected that lengths of conduit, tray, trunking, ladder should be able to be assessed in the same way as for pipework and ducting.</p> <p>Particular information that is required to determine 'approximate quantities' includes:</p> <ul style="list-style-type: none"> • the name of the project (for identification purposes) and the units generally used throughout the project; • the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement • the location and address of a site on which a building is to be located • the building or buildings for which the cost is required (at least one building must be specified) • the building storeys within the building together with their area • the conceptual configuration of building elements • the conceptual configuration of structural elements • the conceptual configuration of distribution systems elements and their separation into distinct systems • values for factors that may affect the quantities including (but not limited to) <ul style="list-style-type: none"> - factor for height working - factor for working in hazardous conditions or in hazardous places - general risk or predictability factors • classification of objects for collection into groups and assemblies for costing purposes
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Exchange_MEP_QTO (Preconstruction_Quantities) [ID:1]

Type	Data Object
Name	Exchange_MEP_QTO (Preconstruction_Quantities)

Documentation

This exchange requirement assumes that a full conceptual building model has been defined and that relevant information can be obtained from shape representations that it contains. The full conceptual model provides sufficient detail to enable the extraction of information to enable the pre-construction quantities to be derived.

Note that the general principles of defining a pre-construction estimate are similar to those for defining an approximate estimate. The difference between the exchange requirements is that the cost value information associated within a pre-construction estimate is expected to be better defined than for an approximate estimate so that it can be used as an indicator of expected construction cost.

Preconstruction quantities determined will be based on a detailed model of the systems layout. The model will enable capture of nominal lengths of flow elements as well as their sizes and elevations. From this, more detailed quantities of insulation and other coverings as well as detailed information about fixings can be obtained. More detailed lengths of flow elements (particularly for pipework and ductwork) could also be obtained to support a highly detailed cutting list for prefabrication of components if necessary.

Systems are expected to be fully detailed at this point with all of the information necessary for quantity takeoff as determined by the method of measurement selected. Note that this does not necessarily mean that every last detailed needs to be included in the model since measurement rules are expected to capture the precise detail.

Note also that, particularly for electrical systems, coordinated design may define the provision of carrying equipment and identify services to be carried, but it is unlikely that the precise routing of all electrical systems will be shown. This is especially true of final circuits which may be defined with 'logical lengths', the extent of which have to be determined in much the same way as was the case for preliminary quantities.

The method of measurement for the quantities should be determined. This will include determining the approach to be used for determining the overall length of flow segments used (pipework, cable or ducting) and how to estimate fittings used.

Classification and naming systems should be selected for identifying elements and their properties. This should include not only the level of detail for components using national classification systems but also the common specification of properties according to a standard dictionary.

Pipework should be set out so that quantities of flow segments at different elevations (below floor, low level, high level and above ceiling) can be found. Once this is established, the following additional quantities can also be determined.

1. Allowances can be made for fixing (hangers and brackets) according to the types required in different situations. Typically however, fixing allowances are made when costing.
2. Weight quantities can be assessed either by system or overall. This is detailed information at this stage and is important both for logistics purposes and also for structural engineering.
3. Because pipe sizes, lengths and elevations are known, labor estimates can be made in terms of time quantities so that an overall assessment of labor requirement can be made.
4. Quantities for procurement can be determined.
5. Length information for cutting, prefabrication, insulation, identification and other purposes can be established.

For ductwork. schedules of flow segments can be determined by length. Flow segments of particular sizes use particular thicknesses of materials in their manufacture and this can give an idea of overall weight.

During this stage the information available is limited to the following requirements:

	<ul style="list-style-type: none"> • a building is defined in terms of its shape and the number of building storeys that it contains (or is expected to contain) • the spatial layout and configuration of elements that define the construction is conceptually established • the services and structure of the building are conceptually established • there are factors that may be applied to affect the ‘approximate estimate’ cost; <p>Particular information that is required to determine pre-construction quantities includes:</p> <ul style="list-style-type: none"> • the name of the project (for identification purposes) and the units generally used throughout the project; • the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement • the location of a site on which a building is to be located • the building or buildings for which the quantities are required (at least one building must be specified) • the building storeys within the building together with their area • the conceptual configuration of building elements • the conceptual configuration of distribution systems elements and their separation into distinct systems • values for factors that may affect the cost; these may include (but are not limited to) <ul style="list-style-type: none"> - factor for height working - factor for working in hazardous conditions or in hazardous places - general risk or predictability factors • classification of objects for collection into groups and assemblies for costing purposes <p>Note that specific pre-construction estimates may be required for particular element groupings either as sections of a whole estimate or as separate estimates. For example, the distribution elements forming the building services system may be within a different pre-construction estimate to the building and structural elements.</p>
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Coordination Point Gateways

Accept Feasibility Design?

Type	Gateway
Name	Accept Feasibility Design?
Documentation	

Accept Feasibility Design?

Type	Gateway
Name	Accept Feasibility Design?
Documentation	

Exchange Requirement

Name Exchange_MEP_QTO (Approximate Quantities)

Identifier

Change Log

2008-08-01 Created

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Project Stage	0	Portfolio requirements	
	1	Conception of need	
	2	Outline feasibility	
	3	Substantive feasibility	
	4	Outline conceptual design	
	5	Full conceptual design	✓
	6	Coordinated design and procurement	
	7	Production information	
	8	Construction	
	9	Operation and maintenance	
	10	Disposal	

Overview

- Please ensure that you have read the process mapping document 'pm_MEP_QTO' before proceeding with this exchange requirement.
- The scope of this exchange requirement is Quantity Take-Off (QTO) for Mechanical, Electrical and Plumbing (MEP) Systems to support Order of Magnitude.
- Exchange requirements for QTO satisfy the provisions of the process 'Quantify Elements' within cost modelling processes.

This exchange requirement assumes that a full conceptual building model has been defined and that relevant information can be obtained from shape representations that it contains. The full conceptual model provides sufficient detail to enable the extraction of information to enable the approximate quantities to be derived. For instance, in defining a system group for a heating system, the group should contain all of the heat emitters within the system

Approximate quantities determined will be based on a model of the systems layout. Since the model is expected to include lengths, sizes and elevations of the flow elements, it is expected that all quantities from this stage onwards are based on a measure of actual elements and not by a historical performance criterion.

It is not necessarily expected however that systems will be fully detailed at this stage. Smaller elements and additions to systems such as air vents, drains, measuring points and instrumentation etc. are likely to be not yet included.

The method of measurement for the quantities should be determined. This will include determining the approach to be used for determining the overall length of flow segments used (pipework, cable or ducting and how to estimate fittings used).

Classification systems should be selected for classifying elements. This includes both the spaces used for area quantification and the elements that are counted. This is relevant for later quantity breakdowns which may be at a further level of decomposition of the information at outline conceptual design.

Pipework should be set out so that quantities of flow segments at different elevations (below floor, low level, high level and above ceiling) can be found. Once this is established, the following additional quantities can also be determined.

1) By considering the configuration of systems (complexity, density etc.), an allowance of additional length quantity of pipework could be made so that it is not necessary to actually count how many of each type of fitting is required

2) The total number of fittings may be counted but rather than counting each individual type, they may be expressed in terms of a 'counted fitting' (the term used to identify the idea of a hybrid fitting consisting of j% elbow, k% tee, m% union, n% bend may vary between places)

3) Counted fittings could be quantified at this stage as being some number per 100m of pipework (e.g. 30 counted fittings per 100m). This is an alternative to adding a length but may be easier than doing an actual fitting count. It has the advantage that it preserves the idea of fittings within a quantity set.

4) Allowances can be made for fixing (hangers and brackets). Typically however, fixing allowances are made when costing. It could be done by making a length allowance to the pipework but this might later distort any quantity take off used for ordering purposes.

5) Weight quantities can be assessed either by system or overall.

6) Because pipe sizes, lengths and elevations are known, labor estimates could also be made in terms of time quantities so that an overall assessment of labour requirement can be made. This is valuable since it facilitates the assessment of local labor availability and/or potential travelling requirements

For ductwork, schedules of flow segments can be determined by length. Flow segments of particular sizes use particular thicknesses of materials in their manufacture and this can give an idea of overall weight. This is relevant since, at this stage, it is common for ductwork costing to be assessed by the weight of material used.

For electrical installations, it is expected at this stage that main distribution cables between distribution boards should be able to be determined by length. However, cabling for final circuits is probably still based on a length assessment by counting runouts to switches, outlets and final loads and then allowing an expected length per runout. However, it is expected that lengths of conduit, tray, trunking, ladder should be able to be assessed in the same way as for pipework and ducting.

Particular information that is required to determine 'approximate quantities' includes:

- the name of the project (for identification purposes) and the units generally used throughout the project;
- the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement
- the location and address of a site on which a building is to be located
- the building or buildings for which the cost is required (at least one building must be specified)
- the building storeys within the building together with their area
- the conceptual configuration of building elements
- the conceptual configuration of structural elements
- the conceptual configuration of distribution systems elements and their separation into distinct systems
- values for factors that may affect the quantities including (but not limited to)
 - factor for height working
 - factor for working in hazardous conditions or in hazardous places
 - general risk or predictability factors
- classification of objects for collection into groups and assemblies for costing purposes

Information Requirements

Technical Issues

This exchange requirement assumes that any software providing a technical solution to this requirement will deal with fundamental issues including those given below. No further reference is made to these items in the exchange requirement. However, further detail can be obtained by reference to the functional parts quoted.

1. All objects as specified will be assigned a globally unique identifier
2. All objects as specified will have an owner history

Preconditions

The provisions of the exchange requirement `er_exchange_building_model` (full concept) must be satisfied

Within the context of this exchange requirement this provides for availability of the following information:

- project information must assert project stage.
- site information must assert
 - postal address for the site
- building information must assert
 - specification of each part of the building and the aggregation of parts of the building into an elemental building and/or building complex
 - specification of the site on which building is contained
 - building name
 - postal address for the building
 - spaces and zones
- building quantities must assert
 - total height of the building
 - footprint area of the building
 - volume of the building
 - number of building storeys within the building
 - quantities related to individual spaces with a building (perimeter lengths, gross/net area floor to ceiling height etc.)
- building properties must assert
 - occupancy type of the building
- building storey information must assert for each storey
 - height of the storey above ground
 - measured area of the storey
- building storey quantities must assert
 - height of the storey

Quantities

Quantities define the amount of something provided for further analysis. In this case, a quantity is an amount that cannot be directly measured from a building information. Therefore has to be interpreted from a combination of:

- a measurement that can be derived directly which is ...
- ...modified by the application of agreed measurement rules.

For technical detail, refer to **`fp_define_quantities`**

For each factor, the following information should be given:

✓	The method of measurement. <i>If a local method of measurement is applicable to order of magnitude costing then this should be stated. Otherwise, it is recommended that the value of this attribute should be set to 'OrderOfMagnitude'</i>
✓	The name of the factor. <i>If there are local measurement rules that identify the factors that may be applied then names used within these rules should be applied. Otherwise, it is recommended that a naming convention should be agreed between the sender and receiver of information identified in this Exchange Requirement.</i>
✓	The value of the factor <i>The actual value to be applied for the factor may be set either during the provision of information for costing or during the actual process of defining costs. A value must however be provided whenever a factor is set. In the absence of particular guidance regarding the setting, a value of 1.0 should be used (so as to have a neutral impact on cost when used as a multiplication factor).</i>
✓	A more detailed description of the factor may be given. <i>This is useful to qualify the name and the value given to the factor in the context of the specific project</i>

<i>concerned.</i>

[Area Quantities]

Area quantities may still be applied for some purposes at this stage. However, this is not generally expected in an MEP context other than as a cross check with item count quantities discussed below.

[Length Quantities]

Length quantities are used for all MEP flow segments (pipes, ducts, cables) together with carriers. Insulation for MEP elements may also be measured at this stage.

Length quantities for pipework will also discriminate between existing and new systems installations.

Knowing the fixing locations of flow elements allows different length quantities to be assessed for working with different hazards (see impact factor below)

Length quantities may assume wastage.

[Count Quantities]

Count quantities shall be determined for specific element types that may be visible at the full conceptual design stage. This might include:

- plant items generally for all types of services including energy conversion devices (boilers, chillers etc.), flow moving devices (fans, pumps etc.), flow storage devices (tanks);
- terminals at which services are delivered or executed including e.g. space heaters, sanitary terminals, air grilles and diffusers, light fittings; the extent of modelling of terminals and therefore their use in deriving quantities needs to be determined by the user;
- intermediate items on distribution systems including flow controllers, flow treatment devices, discrete elements;
- principal flow fittings on distribution systems

[Weight quantities]

Weight quantities are typically determined for:

Items of major plant and equipment that may impose a significant load on the structure. Weights in this case may be given both as delivery weight (dry weight), and operating weight

Sheet metal ducting systems to allow the quantity of metal to be cut to be established (taking account of pattern wastage)

Piping systems so that the operational weight (when full) can be accounted for in structural calculations

[Impact Factors]

Various factors may be provided for the site and building to identify their expected impact on preliminary quantities.

An impact factor may be applied to any other declared quantity and may result in a further quantity e.g..

$$Q_1 * I.F. = Q_2$$

Where Q_1 is the initial quantity, I.F. the impact factor and Q_2 the resulting quantity.

All factors defined within this part of the exchange requirement are considered to be 'count' quantities without units. That is, all factors are considered to be dimensionless and the 'Unit' attribute should not be asserted. Count quantities may be applied as either integer (whole) number values or real (decimal) number values.

These might include (amongst others):

- Height working may increase the time quantity for labor
- Hazardous conditions may increase the time quantity for labor
- Working in cramped, inaccessible or dirty locations may increase the time quantity for labor
- Working in close proximity with other trades may imply risks that may increase the time quantity for labor

It is anticipated that locally extended exchange will define standard names for impact factors that may be applied.

Classification

Site, building and MEP entities having assigned quantities should be classified.

For approximate quantities, classification could be given either in the form of a 'lightweight' reference or it may be given as a full classification.

It is proposed that, for the purposes of this exchange requirement, it is assumed that only lightweight classifications are used for the present

For technical detail, refer to **fp_associate_classification** → **For associating a lightweight reference classification**

✓	Set the identity of the classification notation (classification item reference) to be used
✓	Specify a name that can be used to further clarify the classification notation used in terms of its 'real world' specification. <i>e.g. if the notation is, say 'A210' the name might be 'external wall'</i>
✓	Specify the location from which the classification is referenced. This will typically be a URL string identifying the location of a web page.
✓	Identify the name or label by which the classification used is normally known <i>e.g. NS3420, Omniclass etc</i>
✓	Identify the source (or publisher) for the classification <i>e.g. Standards Norge, CSI etc.</i>
✓	Identify the edition or version of the classification system from which the classification notation is derived <i>e.g. version 3, 2006 etc.</i>

Exchange Requirement

Name Exchange_MEP_QTO (Order_of_Magnitude)

Identifier

Change Log

2008-08-01 Created

jdw@aec3.com

Project Stage	0	Portfolio requirements	
	1	Conception of need	
	2	Outline feasibility	✓
	3	Substantive feasibility	✓
	4	Outline conceptual design	
	5	Full conceptual design	
	6	Coordinated design and procurement	
	7	Production information	
	8	Construction	
	9	Operation and maintenance	
	10	Disposal	

Overview

- Please ensure that you have read the process mapping document 'pm_MEP_QTO' before proceeding with this exchange requirement.
- The scope of this exchange requirement is Quantity Take-Off (QTO) for Mechanical, Electrical and Plumbing (MEP) Systems to support Order of Magnitude.
- Exchange requirements for QTO satisfy the provisions of the process 'Quantify Elements' within cost modelling processes.

For feasibility, it is expected that area quantities will be the primary information available and that this will be in terms of major functional areas and possibly spaces if requirements (through briefing space programming) are already established.

This information is relevant for downstream cost calculations that will most probably use historical information.

The method of measurement for the quantities should be determined. At this stage, it is unlikely to be a rule based method but based on a general measurement of the building / building story shapes. In the absence of an industry standard classification, it is probable that an organization specific classification will be used.

Building information in terms of its purpose/use group should be classified. Building information should include whether it is a new project or a refurbishment.

Major items of plant and equipment may be identified (either specifically or in general terms) and some indication of the performance of such items established.

Quantities are determined from expected major cost breakdowns for the project or, if this is not available, by the primary system types expected to be included within the project.

Specific information required at this stage includes:

- the project for which quantities are to be determined shall be identified (name);
- the units generally used throughout the project shall be set;
- a building shall be identified;
 - it should be of a particular type or perform a particular function (several functions may be identified within a particular type);

- it should be located in a particular place and on a particular site (several alternative locations may be identified; each location should be dealt with individually);
- it has an estimated overall area and/or volume requirement OR it is related by a size factor to a similar previous project about which information is known;
- there are factors that affect the ‘order of magnitude’ quantities for MEP including (but not limited to) items shown below; those that will have an impact on the quantities should be determined;
 - expected building configuration (e.g. multi-storey as opposed to single storey);
 - expected heights of spaces or storeys where it is expected that these will be significantly higher than normal;
 - expected level of servicing for operational and comfort purposes;
 - accessibility of the location;
 - labor resource availability;
- the method of measurement to be used for determination of quantities shall be specified;
- classification to be used should be determined and applied., particularly for classification of objects for collection into groups and assemblies for costing purposes;

Information Requirements

Technical Issues

This exchange requirement assumes that any software providing a technical solution to this requirement will deal with fundamental issues including those given below. No further reference is made to these items in the exchange requirement. However, further detail can be obtained by reference to the functional parts quoted.

1. All objects as specified will be assigned a globally unique identifier
2. All objects as specified will have an owner history

Preconditions

1. The provisions of the exchange requirement **er_exchange_project** must be satisfied.

Project stage must be identified.

2. The provisions of the exchange requirement **er_model_site** must be satisfied.

This is particularly in respect of naming and locating the site(s) upon which the buildings containing engineering services are to stand. Information about latitude, longitude and elevation should be available for logistics assessments.

Building

Information about a building may be available through quantity definition for building and structural work or for other purposes. However, quantities for MEP may be a specific requirement and the information needed for a building in this situation is shown below.

For technical detail, refer to **fp_model_building**

[Generally]

A building must be defined for the order of magnitude quantities to be determined.

A building is (if specified) associated to a site. It is therefore a requirement that, before a building can be specified, a site must exist.

A building may span over several connected or disconnected buildings. To allow for this, a ‘building complex’ can be defined which comprises several elemental buildings.

Similarly, a building can also be broken down into several identifiable parts or sections. To allow for this, a ‘building part’ can be defined such that an elemental building comprises several building parts.

Note that dimensional and shape representation information about the building need not be given at this stage.

Note that reference elevation above sea level of the building and reference elevation above sea level of the terrain around the building are not required for this Exchange Requirement. Elevations necessary may be determined from site information

Building information required to establish ‘order of magnitude’ quantities includes:

✓	Specification of the site on which the building is contained
✓	Specification of building name and description if required
✓	An extended name for the building may also be specified if required
✓	Specification of whether the building concerned is a complex of several buildings, an elemental (single) building or a part of a building.
✓	Where the building is a ‘complex’, identification of the elemental buildings that are nested into the complex
✓	Where the building is a ‘part’, identification of the building into which the part is nested <i>It should be noted that the ‘part’ breakdown of a building may give rise to parts that overlap in terms of their shape content. Therefore, the overall shape of a building should not be derived by adding together the shapes of parts.</i>
✓	The postal address for the building may be given

[Quantities]

The following properties should be given for the building to enable determination of MEP quantities. If not known then an assessment of probable values should be made, this assessment to be subject to correction at a later stage.

✓	The total height of the building. <i>The name of the element quantity should be set to ‘Total Height of Building’</i>
✓	The expected gross planned area of the building. <i>The name of the element quantity should be set to ‘Gross Planned Area of Building’</i> <i>This should initially be for the total gross planned area for all probable storeys of the building. Even if the actual number of storeys is known, the gross planned area at this stage should be the total for the building and not by storey. If a cost calculation on a per storey basis is required then the use of a building storey entity should be substituted for the building entity.</i>
✓	The expected net planned area of the building. <i>The name of the element quantity should be set to ‘Nett Planned Area of Building’</i> <i>This should be the total usable space of the building according to local method of measurement rules</i>
✓	The site coverage or footprint area of the building <i>The name of the element quantity should be set to ‘Building Footprint Area’</i>
✓	The gross volume of the building. <i>The name of the element quantity should be set to ‘Gross Volume of Building’</i>

[Properties]

The following properties should be given for the building if known. If not known then an assessment of probable values should be made, this assessment to be subject to correction at a later stage.

✓	The occupancy type of the building should be given according to the local/national building codes to specify the use or purpose of the building (and therefore how it will be assessed for building codes, fire codes etc. and what design parameters may need to be later applied).
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	Refer to locally extended exchange requirements for further details of agreed occupancy types.
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Quantities

Quantities define the amount of something provided for further analysis. In this case, a quantity is an amount that cannot be directly measured from a building information and that therefore has to be interpreted from a measurement that can be derived directly modified by the application of measurement rules or a value that is directly interpreted and provided according to those measurement rules.

For technical detail, refer to **fp_define_quantities**

For each factor, the following information should be given:

✓	The method of measurement. <i>If a local method of measurement is applicable to order of magnitude costing then this should be stated. Otherwise, it is recommended that the value of this attribute should be set to 'OrderOfMagnitude'</i>
✓	The name of the factor. <i>If there are local measurement rules that identify the factors that may be applied then names used within these rules should be applied. Otherwise, it is recommended that a naming convention should be agreed between the sender and receiver of information identified in this Exchange Requirement.</i>
✓	The value of the factor <i>The actual value to be applied for the factor may be set either during the provision of information for costing or during the actual process of defining costs. A value must however be provided whenever a factor is set. In the absence of particular guidance regarding the setting, a value of 1.0 should be used (so as to have a neutral impact on cost when used as a multiplication factor).</i>
✓	A more detailed description of the factor may be given. <i>This is useful to qualify the name and the value given to the factor in the context of the specific project concerned.</i>

[Area Quantities]

Area quantities shall be determined for spatial structure elements (buildings, storeys, spaces) against which further modelling can take place. Primarily this will be cost modelling and depends on the availability of cost / m² information

[Count Quantities]

Count quantities shall be determined for specific element types that may be visible at feasibility stage of design. This might include major plant items such as transformer, chillers and the like.

Counted objects should be clearly identified for order of magnitude quantities.

[Impact Factors]

Various factors may be provided for the site and building to identify their expected impact on the order of magnitude analysis (quantity and cost).

An impact factor may be applied to any other declared quantity and may result in a further quantity. This exchange requirement does not prejudge whether impact factors and quantity results after their application should be exchanged between a sending and receiving system, whether impact factors are sent but applied at the receiving system or even whether impact factors and their application are determined at the receiving system.

All factors defined within this part of the exchange requirement are considered to be 'count' quantities without units. That is, all factors are considered to be dimensionless and the 'Unit' attribute should not be asserted. Count quantities may be applied as either integer (whole) number values or real (decimal) number values.

These might include (amongst others):

- Site complexity
- Construction complexity
- Services complexity
- Fire safety provision (fabric/structure protection, sprinklers etc.)
- Labor resource availability
- Delivery complexity (logistics)

It is anticipated that locally extended exchange will define standard names for impact factors that may be applied.

Classification

Site, building and MEP entities having assigned quantities should be classified.

For order of magnitude quantities, classification should be given as a 'lightweight' reference.

For technical detail, refer to **fp_associate_classification** → **For associating a lightweight reference classification**

✓	Set the identity of the classification notation (classification item reference) to be used
✓	Specify a name that can be used to further clarify the classification notation used in terms of its 'real world' specification. <i>e.g. if the notation is, say 'A210' the name might be 'external wall'</i>
✓	Specify the location from which the classification is referenced. This will typically be a URL string identifying the location of a web page.
✓	Identify the name or label by which the classification used is normally known <i>e.g. NS3420, Omniclass etc</i>
✓	Identify the source (or publisher) for the classification <i>e.g. Standards Norge, CSI etc.</i>
✓	Identify the edition or version of the classification system from which the classification notation is derived <i>e.g. version 3, 2006 etc.</i>

Exchange Requirement

Name Exchange_MEP_QTO (Preconstruction_Quantities)

Identifier

Change Log

2008-08-01 Created jdw@aec3.com

Project Stage	0	Portfolio requirements	
	1	Conception of need	
	2	Outline feasibility	
	3	Substantive feasibility	
	4	Outline conceptual design	
	5	Full conceptual design	
	6	Coordinated design and procurement	✓
	7	Production information	
	8	Construction	
	9	Operation and maintenance	
	10	Disposal	

Overview

- **Please ensure that you have read the process mapping document ‘pm_MEP_QTO’ before proceeding with this exchange requirement.**
- The scope of this exchange requirement is Quantity Take-Off (QTO) for Mechanical, Electrical and Plumbing (MEP) Systems to support Order of Magnitude.
- Exchange requirements for QTO satisfy the provisions of the process ‘Quantify Elements’ within cost modelling processes.

This exchange requirement assumes that a full conceptual building model has been defined and that relevant information can be obtained from shape representations that it contains. The full conceptual model provides sufficient detail to enable the extraction of information to enable the pre-construction quantities to be derived.

Note that the general principles of defining a pre-construction estimate are similar to those for defining an approximate estimate. The difference between the exchange requirements is that the cost value information associated within a pre-construction estimate is expected to be better defined than for an approximate estimate so that it can be used as an indicator of expected construction cost.

Preconstruction quantities determined will be based on a detailed model of the systems layout. The model will enable capture of nominal lengths of flow elements as well as their sizes and elevations. From this, more detailed quantities of insulation and other coverings as well as detailed information about fixings can be obtained. More detailed lengths of flow elements (particularly for pipework and ductwork) could also be obtained to support a highly detailed cutting list for prefabrication of components if necessary.

Systems are expected to be fully detailed at this point with all of the information necessary for quantity takeoff as determined by the method of measurement selected. Note that this does not necessarily mean that every last detailed needs to be included in the model since measurement rules are expected to capture the precise detail.

Note also that, particularly for electrical systems, coordinated design may define the provision of carrying equipment and identify services to be carried, but it is unlikely that the precise routing of all electrical systems will be shown. This is especially true of final circuits which may be defined with 'logical lengths', the extent of which have to be determined in much the same way as was the case for preliminary quantities.

The method of measurement for the quantities should be determined. This will include determining the approach to be used for determining the overall length of flow segments used (pipework, cable or ducting) and how to estimate fittings used.

Classification and naming systems should be selected for identifying elements and their properties. This should include not only the level of detail for components using national classification systems but also the common specification of properties according to a standard dictionary.

Pipework should be set out so that quantities of flow segments at different elevations (below floor, low level, high level and above ceiling) can be found. Once this is established, the following additional quantities can also be determined.

1. Allowances can be made for fixing (hangers and brackets) according to the types required in different situations. Typically however, fixing allowances are made when costing.
2. Weight quantities can be assessed either by system or overall. This is detailed information at this stage and is important both for logistics purposes and also for structural engineering.
3. Because pipe sizes, lengths and elevations are known, labor estimates can be made in terms of time quantities so that an overall assessment of labor requirement can be made.
4. Quantities for procurement can be determined.
5. Length information for cutting, prefabrication, insulation, identification and other purposes can be established.

For ductwork, schedules of flow segments can be determined by length. Flow segments of particular sizes use particular thicknesses of materials in their manufacture and this can give an idea of overall weight.

During this stage the information available is limited to the following requirements:

- a building is defined in terms of its shape and the number of building storeys that it contains (or is expected to contain)
- the spatial layout and configuration of elements that define the construction is conceptually established
- the services and structure of the building are conceptually established
- there are factors that may be applied to affect the 'approximate estimate' cost;

Particular information that is required to determine pre-construction quantities includes:

- the name of the project (for identification purposes) and the units generally used throughout the project;
- the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement
- the location of a site on which a building is to be located
- the building or buildings for which the quantities are required (at least one building must be specified)
- the building storeys within the building together with their area
- the conceptual configuration of building elements
- the conceptual configuration of distribution systems elements and their separation into distinct systems
- values for factors that may affect the cost; these may include (but are not limited to)
 - factor for height working
 - factor for working in hazardous conditions or in hazardous places
 - general risk or predictability factors
- classification of objects for collection into groups and assemblies for costing purposes

Note that specific pre-construction estimates may be required for particular element groupings either as sections of a whole estimate or as separate estimates. For example, the distribution elements forming the building services system may be within a different pre-construction estimate to the building and structural elements.

Information Requirements

Technical Issues

This exchange requirement assumes that any software providing a technical solution to this requirement will deal with fundamental issues including those given below. No further reference is made to these items in the exchange requirement. However, further detail can be obtained by reference to the functional parts quoted.

1. All objects as specified will be assigned a globally unique identifier
2. All objects as specified will have an owner history

Preconditions

The provisions of the exchange requirement er_exchange_building_model (coordinated) must be satisfied

Within the context of this exchange requirement this provides for availability of the following information:

- project information must assert project stage.
- site information must assert
 - postal address for the site
- building information must assert
 - specification of each part of the building and the aggregation of parts of the building into an elemental building and/or building complex
 - specification of the site on which building is contained
 - building name
 - postal address for the building
 - spaces and zones
- building quantities must assert
 - total height of the building
 - footprint area of the building
 - volume of the building
 - number of building storeys within the building
 - quantities related to individual spaces with a building (perimeter lengths, gross/net area floor to ceiling height etc.)
- building properties must assert
 - occupancy type of the building
- building storey information must assert for each storey
 - height of the storey above ground
 - measured area of the storey
- building storey quantities must assert
 - height of the storey

Quantities

Quantities define the amount of something provided for further analysis. In this case, a quantity is an amount that cannot be directly measured from a building information. Therefore has to be interpreted from a combination of:

- a measurement that can be derived directly which is ...
- ...modified by the application of agreed measurement rules.

For technical detail, refer to **fp_define_quantities**

For each factor, the following information should be given:

✓	The method of measurement. <i>If a local method of measurement is applicable to order of magnitude costing then this should be stated. Otherwise, it is recommended that the value of this attribute should be set to 'OrderOfMagnitude'</i>
✓	The name of the factor. <i>If there are local measurement rules that identify the factors that may be applied then names used within</i>

	<i>these rules should be applied. Otherwise, it is recommended that a naming convention should be agreed between the sender and receiver of information identified in this Exchange Requirement.</i>
✓	The value of the factor <i>The actual value to be applied for the factor may be set either during the provision of information for costing or during the actual process of defining costs. A value must however be provided whenever a factor is set. In the absence of particular guidance regarding the setting, a value of 1.0 should be used (so as to have a neutral impact on cost when used as a multiplication factor).</i>
✓	A more detailed description of the factor may be given. <i>This is useful to qualify the name and the value given to the factor in the context of the specific project concerned.</i>

[Area Quantities]

It is not expected that area quantities for MEP will be used at this project stage. However, provision of builders work information may be relevant as area quantities.

[Length Quantities]

Length quantities are used for all MEP flow segments (pipes, ducts, cables) together with carriers. Insulation for MEP elements may also be measured at this stage.

Length quantities for pipework will also discriminate between existing and new systems installations.

Knowing the fixing locations of flow elements allows different length quantities to be assessed for working with different hazards (see impact factor below)

Length quantities used for procurement requirements (for which a preconstruction estimate is suitable) may differ from measured quantities by whatever contingency factors are allowed. The contingency may make allowance for the number of pipe lengths delivered (where each length has a fixed dimension).

Length quantities may assume wastage.

[Count Quantities]

Count quantities shall be determined for specific element types that may be visible at the coordinated design stage. This might include:

- plant items generally for all types of services including energy conversion devices (boilers, chillers etc.), flow moving devices (fans, pumps etc.), flow storage devices (tanks);
- terminals at which services are delivered or executed including e.g. space heaters, sanitary terminals, air grilles and diffusers, light fittings; the extent of modelling of terminals and therefore their use in deriving quantities needs to be determined by the user;
- intermediate items on distribution systems including flow controllers, flow treatment devices, discrete elements;
- principal flow fittings on distribution systems

[Weight quantities]

Weight quantities are typically determined for:

Items of major plant and equipment that may impose a significant load on the structure. Weights in this case may be given both as delivery weight (dry weight), and operating weight

Sheet metal ducting systems to allow the quantity of metal to be cut to be established (taking account of pattern wastage)

Piping systems so that the operational weight (when full) can be accounted for in structural calculations

[Impact Factors]

Various factors may be provided for the site and building to identify their expected impact on preliminary quantities.

An impact factor may be applied to any other declared quantity and may result in a further quantity e.g..

$$Q_1 * I.F. = Q_2$$

Where Q_1 is the initial quantity, I.F. the impact factor and Q_2 the resulting quantity.

All factors defined within this part of the exchange requirement are considered to be ‘count’ quantities without units. That is, all factors are considered to be dimensionless and the ‘Unit’ attribute should not be asserted. Count quantities may be applied as either integer (whole) number values or real (decimal) number values.

These might include (amongst others):

- Height working may increase the time quantity for labor
- Hazardous conditions may increase the time quantity for labor
- Working in cramped, inaccessible or dirty locations may increase the time quantity for labor
- Working in close proximity with other trades may imply risks that may increase the time quantity for labor

It is anticipated that locally extended exchange will define standard names for impact factors that may be applied.

Classification

Site, building and MEP entities having assigned quantities should be classified.

For approximate quantities, classification could be given either in the form of a ‘lightweight’ reference or it may be given as a full classification.

It is recommended that, for this exchange requirement, lightweight classifications should be used for the present

For technical detail, refer to **fp_associate_classification** → **For associating a lightweight reference classification**

✓	Set the identity of the classification notation (classification item reference) to be used
✓	Specify a name that can be used to further clarify the classification notation used in terms of its ‘real world’ specification. <i>e.g. if the notation is, say ‘A210’ the name might be ‘external wall’</i>
✓	Specify the location from which the classification is referenced. This will typically be a URL string identifying the location of a web page.
✓	Identify the name or label by which the classification used is normally known <i>e.g. NS3420, Omniclass etc</i>
✓	Identify the source (or publisher) for the classification <i>e.g. Standards Norge, CSI etc.</i>
✓	Identify the edition or version of the classification system from which the classification notation is derived <i>e.g. version 3, 2006 etc.</i>

If full classification is used, for technical detail, refer to **fp_associate_classification** → **For associating a full classification**

Full classification should be used for detailed, multi-part classifications. It is recommended for use where more than one classification system is in use or where there may be uncertainty as to the origin or meaning of the classification.

[Classification Notation]

✓	For each facet of the classification to be applied, set the notation value of the facet (the classification). <i>e.g. ‘A210’</i>
✓	Assign the facets to the classification notation as a list <i>e.g. (‘A210’, ‘A211’, ‘A212’) etc</i>

[Classification Item]

✓	Set the name of the classification item or table concerned <i>e.g. 'Table 32'</i> <i>Note that multiple items or tables may be defined</i>
✓	Allocate classification notations to the classification item or table concerned.
✓	Create a hierarchy of the classification items or tables used as necessary <i>e.g. item L6821 is a child of item L682 is a child of item 68 is a child of item 6</i>

[Classification System]

The classification system should only need to be defined once

✓	Identify the name or label by which the classification used is normally known <i>e.g. NS3420, Omniclass etc</i>
✓	Identify the source (or publisher) for the classification <i>e.g. Standards Norge, CSI etc.</i>
✓	Identify the edition or version of the classification system from which the classification notation is derived <i>e.g. version 3, 2006 etc.</i>
✓	Identify the classification items as being within the defined classification system

Exchange Requirement

Name Exchange_MEP_QTO (Preliminary_Quantities)

Identifier

Change Log

2008-08-01 Created jdw@aec3.com

Project Stage	0	Portfolio requirements	
	1	Conception of need	
	2	Outline feasibility	
	3	Substantive feasibility	
	4	Outline conceptual design	✓
	5	Full conceptual design	
	6	Coordinated design and procurement	
	7	Production information	
	8	Construction	
	9	Operation and maintenance	
	10	Disposal	

Overview

- Please ensure that you have read the process mapping document 'pm_MEP_QTO' before proceeding with this exchange requirement.
- The scope of this exchange requirement is Quantity Take-Off (QTO) for Mechanical, Electrical and Plumbing (MEP) Systems to support Order of Magnitude.
- Exchange requirements for QTO satisfy the provisions of the process 'Quantify Elements' within cost modelling processes.

Preliminary quantities determined will be based on the type of element being considered. For some elements, quantities may be assessed by area (for instance, expected number of light fittings per square meter in office spaces). However, quantities for other elements may be based on counting the number expected. The precise method of quantification at this stage is entirely dependent on the way in which historical data is recorded and maintained (whether this is through a public service or whether it is recorded and maintained by a company locally).

The method of measurement for the quantities should be determined. At this stage, it may be a rule based method for areas but there are unlikely to be specific measurement rules for counting objects.

Classification systems should be selected for classifying elements. This includes both the spaces used for area quantification and the elements that are counted. This is relevant for later quantity breakdowns which may be at a further level of decomposition of the information at outline conceptual design.

For pipework and ductwork, the number of 'terminals' that may be located on a system may be used with appropriate factors. For some systems these may be flow terminals; for other systems, the terminal may be a different entity (e.g. a waste outlet or a sanitary element). Where rules/factors can be established that relate a number of units to a length of flow segment, then linear quantities can be established. Rules/factors should be varied according to building type, density of servicing, building usage, overall building shape, number of vertical risers and more.

For electrical systems, using numbers of switches and loads and then allowing a cable length per switch or load can deliver quantities. From this, an expected value of cable carriers (conduit, tray, trunking, ladder) can be assessed.

With linear values established, initial assessments can also be made of delivery quantities and a view taken on the logistics of delivery to site and required storage space. For ductwork and pipework, this may also include making assessments of delivery weights.

Particular information that is required to determine 'preliminary quantities' includes:

- a building is defined in terms of its shape and the number of building storeys that it contains (or is expected to contain)
- it should be located in a particular place and on a particular site
- there are factors that affect the 'preliminary appraisal' quantities including (but not limited to) items such as
 - expected building configuration (e.g. multi-storey as opposed to single storey)
 - expected level of servicing for operational and comfort purposes
 - accessibility of the location
 - labor resource availability
- the name of the project (for identification purposes) and the units generally used throughout the project;
- the current stage of the project; whilst this is generally optional, it should be mandatory for this exchange requirement
- the location the site on which the building is to be located
- the building storeys within the building together with their area (although the shape representation of a building storey is not necessary for this Exchange Requirement)
- the area, volume or size factor of the building
- classification of objects quantified

Information Requirements

Technical Issues

This exchange requirement assumes that any software providing a technical solution to this requirement will deal with fundamental issues including those given below. No further reference is made to these items in the exchange requirement. However, further detail can be obtained by reference to the functional parts quoted.

1. All objects as specified will be assigned a globally unique identifier
2. All objects as specified will have an owner history

Preconditions

The provisions of the exchange requirement er_exchange_building_model (outline concept) must be satisfied

Within the context of this exchange requirement this provides for availability of the following information:

- project information must assert project stage.
- site information must assert
 - postal address for the site
- building information must assert
 - specification of each part of the building and the aggregation of parts of the building into an elemental building and/or building complex
 - specification of the site on which building is contained
 - building name
 - postal address for the building
- building quantities must assert
 - total height of the building
 - footprint area of the building
 - volume of the building
 - number of building storeys within the building
- building properties must assert

- occupancy type of the building
- building storey information must assert for each storey
 - height of the storey above ground
 - measured area of the storey
- building storey quantities must assert
 - height of the storey

Quantities

Quantities define the amount of something provided for further analysis. In this case, a quantity is an amount that cannot be directly measured from a building information. Therefore has to be interpreted from a combination of:

- a measurement that can be derived directly which is ...
- ...modified by the application of agreed measurement rules.

For technical detail, refer to **fp_define_quantities**

For each factor, the following information should be given:

✓	<p>The method of measurement.</p> <p><i>If a local method of measurement is applicable to order of magnitude costing then this should be stated. Otherwise, it is recommended that the value of this attribute should be set to 'OrderOfMagnitude'</i></p>
✓	<p>The name of the factor.</p> <p><i>If there are local measurement rules that identify the factors that may be applied then names used within these rules should be applied. Otherwise, it is recommended that a naming convention should be agreed between the sender and receiver of information identified in this Exchange Requirement.</i></p>
✓	<p>The value of the factor</p> <p><i>The actual value to be applied for the factor may be set either during the provision of information for costing or during the actual process of defining costs. A value must however be provided whenever a factor is set. In the absence of particular guidance regarding the setting, a value of 1.0 should be used (so as to have a neutral impact on cost when used as a multiplication factor).</i></p>
✓	<p>A more detailed description of the factor may be given.</p> <p><i>This is useful to qualify the name and the value given to the factor in the context of the specific project concerned.</i></p>

[Area Quantities]

Area quantities may be determined for spatial structure elements (buildings, storeys, spaces) and used for measuring quantities for systems/situations where elemental (count) quantities are not possible. These quantities can also be used as a cross check with item count quantities discussed below.

[Count Quantities]

Count quantities shall be determined for specific element types that may be visible at outline concept stage of design. This might include:

- plant items generally for all types of services;
- terminals at which services are delivered or executed including e.g. space heaters, sanitary terminals, air grilles and diffusers, light fittings; the extent of modelling of terminals and therefore their use in deriving quantities needs to be determined by the user

Note that area quantities and count quantities may both be provided to cover quantities of a topic of interest e.g. lighting systems. However, only one method of measurement should be allowed per topic other than for comparison purposes.

[Impact Factors]

Various factors may be provided for the site and building to identify their expected impact on preliminary quantities.

An impact factor may be applied to any other declared quantity and may result in a further quantity e.g..

$$Q_1 * I.F. = Q_2$$

Where Q_1 is the initial quantity, I.F. the impact factor and Q_2 the resulting quantity.

All factors defined within this part of the exchange requirement are considered to be ‘count’ quantities without units. That is, all factors are considered to be dimensionless and the ‘Unit’ attribute should not be asserted. Count quantities may be applied as either integer (whole) number values or real (decimal) number values.

These might include (amongst others):

- Site complexity
- Construction complexity
- Services complexity
- Fire safety provision (fabric/structure protection, sprinklers etc.)
- Labor resource availability
- Delivery complexity (logistics)

It is anticipated that locally extended exchange will define standard names for impact factors that may be applied.

Classification

Site, building and MEP entities having assigned quantities should be classified.

For preliminary quantities, classification should be given as a ‘lightweight’ reference.

For technical detail, refer to **fp_associate_classification** → **For associating a lightweight reference classification**

✓	Set the identity of the classification notation (classification item reference) to be used
✓	Specify a name that can be used to further clarify the classification notation used in terms of its ‘real world’ specification. <i>e.g. if the notation is, say ‘A210’ the name might be ‘external wall’</i>
✓	Specify the location from which the classification is referenced. This will typically be a URL string identifying the location of a web page.
✓	Identify the name or label by which the classification used is normally known <i>e.g. NS3420, Omniclass etc</i>
✓	Identify the source (or publisher) for the classification <i>e.g. Standards Norge, CSI etc.</i>
✓	Identify the edition or version of the classification system from which the classification notation is derived <i>e.g. version 3, 2006 etc.</i>