

Total Cost of Ownership - Facilities Management Standard Volume 1, September 11, 2014

OFFICES OF FACILITIES PLANNING & CONSTRUCTION, BUILDING AND GROUNDS, PURCHASING

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Executive Summary

The Total Cost of Ownership of a capital facility includes non-recurring costs such as planning and design, bidding, financing, building and commissioning the project and the cost to decommission, demolish and dispose of the project at the end of its lifecycle. It will also include operating costs through the entire lifecycle of the project such as staffing, janitorial, planned maintenance, unplanned maintenance necessary to make repairs, utilities and the cost of retrofits and improvements over time, modifications to support changing program needs, and the replacement or upgrade of systems as they reach the end of their life-cycles.

Total Cost of Ownership in and of itself is really just a Key Performance Indicator of how cost effective an organization designs, constructs, operates, maintains, upgrades and renovates its capital facilities. The purpose of any Total Cost of Ownership Management Plan is to effectively utilize resources to insure a healthy, comfortable and sustainable learning environment. Implementing strategies, standards and best practices that achieve measurable results is a large part of this process but also, establishing a vision, commitment and a clear direction is necessary to ensure the continued management and care of capital resources for the benefit of future generations.

The idea of generational trust for educational facilities is consistent with the concept of *stewardship*, to be entrusted with the care of another person's property or financial affairs or, in the words of Teddy Roosevelt, the buildings and grounds of an institution must be treated "as assets which must be turned over to the next generation increased; and not impaired in value.

Ideally, a statement proclaiming stewardship principles should form the grounding for a comprehensive facilities plan or master plan. Also ideally, facilities stewardship should reflect a broad responsibility of governing board members and senior leaders in addition to the president or chancellor. Today, as the average tenure of a president/chancellor is less than seven years, their decisions must be part of a lengthy, continuous stewardship process, protected because it is an indispensable, shared responsibility.

Facilities stewardship is a high-level and pervasive commitment to optimize capital investments, in order to achieve a high-functioning and attractive campus. It includes a major commitment to capital asset preservation and quality. City College of San Francisco is one of the largest community colleges in the country and has served the educational needs of San Francisco residents for 80 years. Stewardship is about the long view of this institution's past and future. It forms the backdrop for hundreds of discrete facilities investment and management decisions. Ultimately, facilities stewardship is one of the most compelling responsibilities of institutional leadership.



Objectives of this Manual

The purpose of this Volume 1 of this Standard is to provide a foundation for implementing the data processes, procedures, and analytical criteria through planned cost accounting, data sharing and collaborative initiatives that support reduction of the Total Cost of Ownership. This foundation will provide the basis for the development of financial and automated systems that will eventually tie all the data collection points together. The resulting data will inform business decisions that will enhance the support of operational missions with scarce resources. The successful implementation of the process(s) described in this manual will be evident in the reduction of lifecycle cost as demonstrated in the data that will be available to current decision makers.

Deliverables of this Total Cost of Ownership Management Plan Volume 1 are the reduction of capital repairs and costs, unscheduled shutdowns and repairs, extending both equipment life and facility life, realizing life-cycle cost-savings, maintaining a safe, functional systems and facilities that support the college's mission and providing the proper data for planning, operating, maintaining and staffing the facility(s).

Volume 1 is also describes the various facilities management best practices that occur throughout the life-cycle of our buildings and infrastructure. Many of these best practices are already addressed in the "CCSF Sustainability Plan for Construction, Retrofitting and Operations Part 1 dated December 17, 2009". This Sustainability Plan presents the guidelines for the long-term development and operation of sustainable campuses to be used as an educational resource for all offices, departments, and Shared Governance bodies and as a guide for all employees involved in planning, design, construction, operations, maintenance and deconstruction activities, and procurement of all materials, supplies and equipment. Part 1 of the Sustainability Plan rests on the Mission Statement of the College and make explicit the intention of the Strategic Plan to meet the needs of the community in a socially, environmentally and economically responsible way.

The Total Cost of Ownership Management Plan Volume 2 will provide phasing, planning, budgeting and scheduling for the full implementation of an integrated facilities management solution.



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1.0 Introduction

“We no longer build buildings as we used to, nor do we pay for them in the same ways. Buildings today are life support systems, communication terminals, data manufacturing centers, and much more. They are incredibly expensive tools that must be constantly adjusted to function efficiently. The economics of building has become as complex as its design¹”.

As the educational building boom that started in 1998 comes to a close, campus administrators and governing boards statewide are facing the increased financial obligations necessary to maintain and operate expanded facilities portfolios. Most of the school planning and construction of the past decade was allocated to design and construct new buildings to increase capacity and relieve overcrowding. For all of the scrutiny that planning and construction of new educational facilities received, the operational requirements of those new buildings were largely ignored and during that time the deferred maintenance backlog on existing facilities continued to grow. Much of that same pre-1998 inventory is still in use today, with increased repair and maintenance needs, upgrades needed to accommodate new instructional technologies and modern educational programs and, the growing backlog of deferred maintenance.

Now, fourteen years later the state is in a much different place. An economic recession, reduction of available funding and a focus on sustainability have created a need for facilities managers to reexamine traditional facility operations and management. Many campus administrators are discovering that maintaining and operating their facilities require financial obligations of an unexpected magnitude.

Every facilities professional would agree that designing and constructing cost-effective facilities is a desirable outcome that should help mitigate the costs of operating and maintaining those facilities. But what is cost-effective building? In many respects that opinion will be influenced by individual interests, objectives and how cost-effective is defined.

It is impossible to summarize cost-effectiveness by a single parameter. Determining true cost-effectiveness requires a life-cycle perspective where all costs and benefits of a given project are evaluated and compared over its useful service life. In economic terms, a building design is deemed to be cost-

¹ Wilson, J., “Foreword,” in *Building Economics*, H. E. Marshall and R. T. Ruegg, New York: Van Nostrand Reinhold, 1990



effective if it results in benefits equal to those of alternative designs and has a lower Total Cost of Ownership.

2.0 Total Cost of Ownership

Adopting a new planning process such as Total Cost of Ownership Management is a commitment to change and improvement. A framework for High-Performance starts with a systematic approach to assessing the current state of the various facilities processes and functions, defining strengths and weaknesses, closing the gap between the current and high-performance state, and enabling a culture of continuous improvement.

Reducing TCO requires the creation of a culture that maintains focus and sustains expectations. To foster a proactive and positive environment, managers must keep the focus on identifying issues, applying effective root-cause analysis, and eliminating the causes of asset-reliability problems. Organizations also can create a structure and systems that promote a proactive approach to maintenance and engineering activities by:

- developing staff competencies
- defining roles and responsibilities clearly
- measuring performance
- providing feedback and counseling
- promoting a focus on quality and precision
- ensuring adequate facilities and resources

3.0 Benchmarking

The plan is to reduce TCO by establishing best practices and measuring results. Leadership, from the top of the organization down to department-level managers, needs to set the expectations across the organizational silos. This process starts with establishing vision, alignment and clear direction, as well as recognizing results. Establish a team approach and collaborated metrics. Reducing TCO requires that different groups must collaborate. Managers need to establish cross-functional metrics, make sure everyone clearly understands expectations, and tie accountability for metrics into the performance-management system.

Benchmarking is a multiple step process that allows an organization to compare the aspects of performance, identify the differences, seek out alternative approaches, and assess opportunities for



improvement, implement the change, and monitor outcomes. It should all begin with an internal evaluation, comparing performance matrices of your own organization over time. In the field of facility management these matrices can include operating costs, space utilization, operations and maintenance activities, moves and facility management staffing.

Benchmarking is used to measure performance using a specific indicator (cost per unit of measure, productivity per unit of measure, cycle time of x per unit of measure or defects per unit of measure) resulting in a metric of performance that is then compared to others. This process is used in management, particularly strategic management, in which organizations evaluate various aspects of their processes in relation to best practice companies' processes, usually within a peer group defined for the purposes of comparison. This allows organizations to develop plans on how to make improvements or adapt specific best practices, usually with the aim of increasing some aspect of performance. Benchmarking may be a one-off event, but is often treated as a continuous process in which organizations continually seek to improve their practices.

3.1 Key Performance Indicators

Of the facility management data published by trade and professional associations for comparing efficiency in the use of facilities, nearly all rely on comparing factors on a per square foot of occupied space or gross area basis. The majority of the metrics used to measure facilities performance are cost-centered; some quality rating metrics do exist. They provide a sound basis for early lifecycle cost advice and the development of lifecycle cost plans. Increasingly, this data is taking on a new importance as the community college system places more emphasis on sustainability and whole life costs.

Annualized Total Cost of Ownership (TCO)/Lifecycle Cost Management: Total cost of ownership (TCO) is a dollar per square foot value (\$#/square foot) associated with a facility. It is a calculation of all facilities-specific costs (not including furnishings or non-facility specific equipment) divided by estimated lifespan of the building (30 or 50 years), and the total gross area. Facilities specific costs include all construction, preservation, maintenance, and operations costs. A strategic asset management practice that considers all costs of operations and maintenance, and other costs, in addition to acquisition costs. TCO therefore includes the representation of the sum total of the present value of all direct, indirect, recurring and non-recurring costs incurred or estimated to be incurred in the design, development, production, operation, maintenance of a facility/structure/asset over its anticipated lifespan. (Inclusive of site/utilities, new construction, deferred maintenance, preventive/routine maintenance, renovation, compliance, capital renewal, and occupancy costs.)



Facility Condition Index (FCI): A comparative industry indicator/benchmark used to indicate the relative physical condition of a facility, group of buildings, or entire portfolio “independent” of building type, construction type, location or cost. The facility condition index (FCI) is expressed as a ratio of the cost of remedying existing deficiencies/requirements, and capital renewal requirements to the current replacement value (i.e., $FCI = (DM+CR)/CRV$). The FCI provides a corresponding rule of thumb for the annual reinvestment rate (funding percentage) to prevent further accumulation of deferred maintenance deficiencies. The FCI value is a snapshot in time, calculated on an annual basis. Forecasted FCI values for a building in the future, for example, would include the current deferred maintenance items, plus projected values of capital renewal requirements. The FCI is represented on a scale of zero to one, or 0% to 100%, with higher FCI values, representing poorer facility’s condition. While property owners/managers establish independent standards, a “fair to good facility” is generally expressed as having an FCI of less than 10-15%.

Deferred Maintenance/Deferred Maintenance Backlog/Accumulated Deferred Maintenance Backlog: The total dollar amount of existing maintenance repairs and required replacements (capital renewal), not accomplished when they should have been, not funded in the current fiscal year or otherwise delayed to the future. Typically quantified by a comprehensive facilities condition assessment/audit of buildings, grounds, fixed equipment and infrastructure. These needs have not been scheduled to be accomplished in the current budget cycle and thereby are postponed until future funding budget cycles. The projects have received a lower priority status than those to be completed in the current budget cycle. For calculation of facility condition index (FCI) values, deferred maintenance does not include grand fathered items (e.g., ADA), or programmatic requirements (e.g., adaptation).

Facilities Deterioration Rate: Facilities and equipment are in a constant state of degradation. While identified deficiencies/requirements are being corrected, other deficiencies/requirements are continuously being created over time. The rate of deterioration may be expressed as a percentage of current replacement value per year. While degradation rates vary as a function of multiple variables such as building type, current conditions, geographic location, etc., a benchmark deterioration rate for a reasonably well maintained facility is approximately 2.5% per annum. Varying annual capital reinvestments into the physical plant and equipment may alter the degradation rate. The facility condition index (FCI) can be used as comparative metric to help monitor degradation rates.

Deficiency/Requirement (Facility/Structure/Asset): The quantitative difference, typically in terms of dollars amount and associated physical requirements, between an assets current physical or functional condition, and an established minimum level of condition/performance. Any problem or defect with materials or equipment.



Recapitalization/Reinvestment Rate: A facility, system, or component with existing deficiencies will deteriorate at a faster rate than a component that is in good condition. The level of annual funding for facility renewal and deferred maintenance expressed as a percentage of facility replacement values. Altering the recapitalization/reinvestment rate has direct impact upon the facility condition index (FCI) and associated deferred maintenance levels over time.

Facility Operating Gross Square Foot (GSF), Index (SAM Performance Indicator: APPA 2003): A strategic asset management practice that considers the yearly costs of facilities operations and maintenance as compared to the APPA Facility Operating Gross Square Foot SAM Performance Indicator.

Custodial Costs per square foot: An asset management practice that considers the yearly costs of custodial labor, materials and equipment.

Grounds Keeping Costs per square foot: An asset management practice that considers the yearly costs of grounds labor, materials and equipment.

Energy Costs per square foot: An asset management practice that considers the yearly costs of gas and electricity.

Utility Costs per square foot: An asset management practice that considers the yearly costs of utilities.

Waste Removal Costs per square foot: An asset management practice that considers the yearly costs of waste management.

Facility Operating Current Replacement Value (CRV) Index: A strategic asset management practice that considers the total cost replace facilities and infrastructure.

4.0 Life-Cycle Cost-Effective Facilities

Currently, the California Community Colleges Board of Governors provides for incentives and funding augmentations to achieve optimum energy utilization, low life-cycle operating costs, and compliance with applicable energy codes and regulations on all new construction, remodeling, renovation, and repair projects². The California Education Code, Sections 81700-81708 addresses life-cycle cost by allowing a community college district to include life-cycle costs in evaluating Design-build Proposals. The economic

² Energy and Sustainability Policy of the Board of Governors of the California Community Colleges.



incentives to adopt life-cycle cost analysis and other sustainability best practices at the design phase were presented by the Sustainability Coordinator at the California Division of the State Architect who stated that “minimal increases in upfront costs of 0-2% to support green design will result in life cycle savings of 20% of total construction costs -- more than ten times the initial investment”.

CCSF has determined that, by focusing on reducing the life-cycle costs of its facilities, CCSF can minimize its Total Cost of Facility Ownership. CCSF incorporates life-cycle cost-effective practices into many aspects of the planning, design and construction processes.

4.1 Life-Cycle Cost in Planning, Design and Construction

The college in the process of establishing design standards that provide clear guidance for the selection of life-cycle cost-effective building systems. The use of design-build construction, requiring facilities that are designed and constructed to Leadership in Energy and Environmental Design (LEED) Silver or Gold facility ratings and adding life-cycle cost-effectiveness to performance-based specifications and proposal-evaluation criteria are opportunities to achieve more energy-efficient, cost-effective facilities. BIM, building commissioning and verification of energy savings may represent design and construction contracting tools available to fully realize promised life-cycle savings.

4.2 Building Information Modeling

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility that provides a shared knowledge resource and a reliable basis for decisions during its life-cycle; from earliest conception to demolition. Building Information Modelling (BIM) is changing how buildings, infrastructure, and utilities are planned, designed, built, and managed and supports the delivery of more innovative, cost-efficient buildings through integrated information and collaboration. CCSF has developed a BIM Standard³ that is currently in the approval process.

³ CCSF BIM Standards, February 2014



BIM represents a design as combinations of objects, generic or product-specific, solid shapes or void-space oriented (like the shape of a room), that carry their geometry, relations and attributes. BIM design tools allow extraction of different views from a building model for drawing production and other uses. These different views are automatically consistent, being based on a single definition of each object instance. BIM software also defines objects parametrically; that is, the objects are defined as parameters and relations to other objects, so that if a related object is amended, dependent ones will automatically also change. Each model element can carry attributes for selecting and ordering them automatically, providing cost estimates as well as scheduling, material tracking and ordering.

Building Information Modeling (BIM) goes well beyond geometry, spatial relationships, light analysis, geographic information, quantities and properties of building systems, assemblies and components. BIM spans all aspects of the entire building life cycle, including but not limited to Needs Analysis, Capital Planning and Management, Construction Delivery Methods Design, Procurement, Construction, Repair, Maintenance, Sustainability, Renovation, Operations, Space Management, Deconstruction/Reuse. It addresses not only form, fit and function but activities that are traditionally not addressed with 2D or 3D CAD/Visualization.

The California Community College Chancellor's Office has committed to integrating Building Information Modeling (BIM), Facility Management and Geographic Information Systems (GIS) with the implementation by connecting 71 million square feet of facilities through BIM, FM and GIS using the ONUMA Planning System. The Foundation for CCC is also initiating other open standard systems: Facility Management, Computerized Maintenance Management (CMMS), BAS (Building Automation Systems), EMS (Energy Management Systems) and classroom scheduling that take advantage of this technology.

4.3 Onuma Planning System

The ONUMA system is a web-based Building Information Modeling (BIM) tool. It has been used for years in the design and management of projects and facilities. The ONUMA system is used in FUSION/ONUMA to connect data from the various systems and provide access to data in a graphical format. One of the most powerful features of the ONUMA system is how it manages spatial data. The "Guidelines" place emphasis on how space (room) data is represented and captured in the various BIM/CAD applications to be integrated to FUSION+GIS+ONUMA. That space (room) data is extracted or converted and merged with other data streams to create more intelligent objects to be used in FUSION+GIS+ONUMA.

FUSION (Facilities Utilization, Space Inventory Options Net) is a database of 71-million square feet of California community college facilities that tracks the condition assessments and develops cost modeling for maintenance projects, enabling colleges to plan budgets and help facilitate the passing of much-



needed bond measures. FUSION has a consistent classification system for all California community colleges.

The FUSION/ONUMA system presents an opportunity to greatly simplify the use of project data in FUSION. Every CCC district using FUSION has ongoing construction, renovation, and maintenance projects; however, the deliverables from these projects, such as BIM Models, computer-aided design (CAD) or other associated data files, often are not in alignment with the FUSION system. Because of this incompatibility, the data has to be re-collected and manually entered. With the approach outlined in this document, including slight adjustments to standard contract language regarding deliverables, contractor data can now be imported into the FUSION system without the need for manual entry, thus continually enhancing FUSION data. This simplified process will provide tremendous value for the districts, increase the accuracy of facility data, and reduce the cost of maintaining data.

CCSF has initiated the process to implement deployment of the ONUMA/FUSION system. The college will work collaboratively with the California Community College Chancellor's Office throughout this process.

4.4 COBie2

Currently, most construction documents at California Community Colleges require the handover of paper documents containing as-built plans, equipment lists, product data sheets, warranties, spare part lists, preventive maintenance schedules, and other information that is essential to support the operations, maintenance, and management of the facility by the district. Gathering this information at the end of the job, today's standard practice, is expensive, since most of the information has to be recreated from information created earlier. COBie simplifies the work required to capture and record project handover data which can be populated directly into FUSION/ONUMA and the College's CMMS.

The COBie approach is to enter the data as it is created during design, construction, and commissioning. Designers provide floor, space, and equipment layouts. Contractors provide make, model, and serial numbers of installed equipment. Much of the data provided by contractors comes directly from product manufacturers who also participate in COBie. At the early stages of design, the vertical and horizontal spaces that are necessary to fulfill the district's requirements for the building, facility, or infrastructure project are defined. Within these buildings, facilities, or projects are also defined the different types of systems which can include electrical, heating, ventilating and air conditioning (HVAC), potable water, wastewater, fire protection, intrusion detection and alarms and other systems.

COBie data begins with the listing of one or more buildings or projects. If these are buildings each has one or more floors and within each floor there are spaces which will have room numbers. Outside the



building, spaces can be referenced by function, such as parking lot or patio seating. COBie allows the two-way exchange of space function, area calculations and other information between ONUMA/FUSION and the designers' CAD or BIM software. Digital information in IPPs and FPPs created as part of the capital outlay program and space inventory information refined during the design process is readily available to project stakeholders and retained in the ONUMA/FUSION site as well as at the districts.

As the design progresses the material, products, and equipment needed for the building are specified. The types of products are most often displayed as finish, product, and equipment schedules. The use of these schedules for any variety of reasons, including quantity take off, asset management, and of course facility maintenance and operations requires multiple, error-prone manual transcriptions.

The types of equipment are listed along with the specific location of each of these types. Product's properties are listed as COBie common attributes. With these data structures, COBie transfers schedule information from designers to builders and later to operators. Information within the COBie file allows the designer to identify fixed or movable property. Components are organized into systems that are also listed in COBie. These systems provide specific building services to building occupants such as alarms, electrical, fire protection, HVAC, plumbing systems, and others. Currently an optional COBie set of data are the connections between equipment. Connections allow the designers to specify how specific pieces of equipment are logically connected. This would allow, for example, a worker to know what other equipment would be effected if a valve closed or an electrical circuit de-energized.

During the design there may be documents of interest pertaining to specific parts of the building. These documents can be linked by reference to the COBie documents data. Designers may also specify the requirements for documents in COBie. One of the most common lists of required documents is the submittal register. The submittal register is a key aspect of COBie since it is the approved submittals during construction that comprise the bulk of construction handover data sets.

As the project progresses from design to construction, the next stage of the project that contains COBie data occurs when the contractor provides submittals for the designer specified required documents. COBie information exchange allows electronic copies acknowledged or approved submittals to be directly linked to specific types of materials, products, equipment, and systems within the building. The majority of these linked documents are provided as PDF files from documents already created by product manufacturers. Shop drawings should be lined in their native CAD/BIM formats as well as in PDF-views. Scanned or photographic images are required for submittals that require physical samples. When the COBIE data is transmitted these files are provided with the COBIE file on a COBIE data disk.



Once the equipment is installed and tested, the systems are turned on and made operational for O&M staff. In COBie, there are several documents that describe system operations. These documents include Instructions, Tests, and Certifications. As with all other submittals COBie documents are provided in native or PDF format and referenced in the COBie Documents data set.

4.5 Cost Management and Building Economics

Cost Management is typically concerned with the initial costs of accomplishing new construction or renovation projects. A project must start right in order for it to finish right, so the establishment of an appropriate budget is critical. Early in the planning stages, both building owners and designers must agree on an anticipated cost of the project at bid award. This is a critical stage in the cost management process, an inaccurate budget can doom a project to continual stress and compromise, with the district, end-user, and design team being completely unsatisfied with the results. It is important to apply adjustments for factors which affect construction costs, size of the project, renovation versus new, location, price increases since the date of the data used, method of procurement, overall quality of the space envisioned, LEED rating desired if any, access and locational factors such as dense urban, traffic and sidewalk protection, water location, bid competitiveness in the local market, etc.

Economic analysis is the monetary evaluation of alternatives for meeting a given objective. For example, to meet the need for additional classroom space one might consider new construction, renovating an existing facility, or leasing another building. The evaluation is based on a comparison of discounted costs and benefits over a fixed time period of time. Alternatives can be summarized in terms of the ratio of total benefits to total cost (benefit-cost ratio) or equivalently, the total net benefits (net present value).

Life-Cycle Cost Analysis (LCCA) is a cost-effectiveness study that has been used for the comparison of building projects or for the evaluation of energy and water conservation measures. Life cycle costs should include all costs of building ownership over its service life, including construction, maintenance and operations, recapitalization, and disposal. Alternatives can be evaluated on the basis of discounted total cost, or the net savings relative to a do nothing alternative such as the savings-to-investment ratio, internal rate of return, or time to payback.

Value Engineering is an evaluation procedure directed at analyzing the function of materials, systems, processes, and building equipment for the purpose of achieving required functions at the lowest total cost of ownership. Value Engineering is the elimination or modification of anything that adds costs without contributing to the program's functional requirements. Reductions in a project's scope or quality to get it into budget are simply cost cutting, not Value Engineering.



Many public works projects undergo both Value Engineering studies and Life-Cycle Cost Analysis, and while these serve separate purposes, the consideration of design alternatives is often interrelated. For example, value engineering can be used to complement a life-cycle cost analysis when selected Life-Cycle Cost Analysis alternatives cannot be adopted without exceeding the project budget. Value Engineering can be utilized to reduce initial costs of design features other than those under study in a Life-Cycle Cost Analysis. If the VE effort results in sufficient reduction in initial costs, savings may allow selected Life-Cycle Cost Analysis alternatives to be adopted within the overall program budget, thus optimizing the long-term cost-effectiveness of the project as a whole.

5.0 Life-Cycle Asset Management

City College of San Francisco has a space inventory of 2,111,436 square feet and in fiscal year (FY) 2013, will have spent over \$10 million operating and maintaining those facilities. These expenditures represent the operational components of life-cycle costs which include energy and water, operations, janitorial, maintenance and repair costs. To date, the college has allocated \$41 million, or \$19.42 per square foot, of GO Bond funds for Capital renewal/reinvestment. These Capital renewal/reinvestment expenditures address energy management and accessibility issues. The current FUSION deferred maintenance backlog, subject to verification, is \$218 million or \$103.25 per square foot. The current Capital renewal/reinvestment need is \$119 million or \$53.40 per square foot.

Currently, other than the FUSION Facilities Condition Assessment module, there are no mechanisms in place to identify and quantify the backlog of deferred maintenance or the long-term cost of maintaining and operating the college's facilities. CCSF recognizes the need to establish best practices that recognize the environmental, economic, and social benefits of resource efficiency and sustainability; that maximize the life of the facilities and delay their obsolescence and; to provide for a planned program of repairs, improvements and restorations to make them suitable for organizational needs.

A Life-cycle asset management consists of two components; a task plan and a funding plan. The task plan is of distinct value to Building and Grounds personnel in identifying the specific tasks which must be undertaken to improve the condition of the facility. The funding portion of the plan is of value to management in planning for and justifying future funding requirements.

The deferred maintenance reduction plan derives directly from specific deficiencies. By grouping deficiencies by priority and building sub-component for example, a number of individual tasks can be packaged into a manageable piece of work for staff or contractors.



The funding plan will normally incorporate deferred maintenance and component renewal costs. Preventative maintenance costs and any known future functional upgrading costs can also be included if appropriate.

The Life Cycle Asset Management model is a simple but effective tool for managing the future condition of a facility. It can be applied to new or older facilities and can usefully be applied to all district buildings and campuses. The concept of the facility condition index allows buildings, areas within buildings, components or sub-components to be prioritized. This is of particular value in making decisions as to where limited funds should be spent.

Life Cycle Asset Management is best utilized as part of the computer-aided facility management CAFM system and interoperable with the CMMS and FUSION/ONUMA software.

5.1 Capital Renewal

Capital renewal is the planned replacement of building subsystems such as roofs, electrical systems, HVAC systems and plumbing systems that have reached the end of their useful life. Many of the buildings at CCSF that may serve well in the 21st century already exist but major capital renewal investments are required to replace old, obsolete building subsystems that have reached the end of their lifecycle. Without significant reinvestment in building subsystems, older facilities will fall into a state of ever deteriorating condition and the maintenance and repair costs necessary to keep those aging buildings functional will increase as well. Without due attention, replacement facilities will be required and capital expenditure and resource use will increase unnecessarily.

Typically, using a fixed percentage of the facilities current replacement value (CRV) is an accepted approach to funding facilities renewal budgets. Total current replacement value of all facilities is calculated based upon current published construction costs. The institution then chooses a fixed percentage of the total CRV to determine how much should be allocated annually. In 1989 a report published by the Society for College and University Planning (SCUP) has recommended 1.5% to 2.5% of CRV. Other studies recommend slightly lower ranges of 1% to 2%. A recognized need to incorporate life-cycle cost-effective practices not just into the first costs; planning and construction of facilities but also into energy management, janitorial, operations and maintenance and; future costs including capital investment, capital-replacement, and resale, salvage, and/or disposal costs is necessary to maximize efficient operations and minimize costs.



5.2 Capital (Major) Maintenance/Repairs

The systematic management process of planning and budgeting for known future cyclical repair and replacement requirements that extend the life and retain the usable condition of facilities and systems, not normally contained in the annual operating budget. This includes major activities that have a maintenance cycle in excess of one year (e.g., roof replacement, paint buildings, resurfacing pavement, etc.). The cyclical replacement may be for all or a significant portion (e.g., the replacement of 50% or more of a building system component (lighting system, roof system, etc.) as it reaches the end of its useful life, of major components or infrastructure systems, at or near the end of their useful service life. These activities may extend the useful life and retain the usable condition of an associated capital asset (e.g., replacement of an HVAC system, extending the usable life of a facility). Replacement may be capitalized based on the Governmental Accounting Standards Board/Financial Accounting Standards Board (GASB/FASB) definition. A depreciation model calculates a sinking fund for this maintenance activity. Costs are estimated by a current replacement value that is derived by the California Construction Cost index is developed based upon the Building Cost Index (BCI) cost indices for San Francisco and Los Angeles produced by Engineering News Record (ENR) and reported in the second issue each month for the previous month.

5.3 Deferred Maintenance

Deferred maintenance is defined as maintenance work that has been deferred on a planned or unplanned basis to a future budget cycle or postponed until funds are available. Roof repairs, building component repairs, mechanical equipment, underground utilities, and roads and walkways are projects that are often deferred to the next annual funding cycle. This definition could serve just as well for major maintenance and offers a temptation to bypass the use of annual operating budgets and fund major maintenance through a deferred maintenance reduction program. The difference is that a deferred maintenance program is a comprehensive, one-time approach, often extended over several years, to control a massive backlog of maintenance work.

A facility, system, or component with existing deficiencies will deteriorate at a faster rate than a component that is in good condition. The level of annual funding for facility renewal and deferred maintenance expressed as a percentage of facility replacement values. Altering the recapitalization/reinvestment rate has direct impact upon the facility condition index (FCI) and associated deferred maintenance levels over time.



Deferred maintenance reduction programs result from a campus policy to group deferred major maintenance projects, and sometimes other plant needs, into a program funded separately from major maintenance or capital renewal and replacement.

Major maintenance and deferred maintenance are expenditure programs designed to accommodate the deterioration process of facilities; both programs cope with facilities renewal. As a strategy to achieve funding to eliminate problems of facilities deterioration, deferred maintenance reduction programs can be expanded to include life safety, code compliance requirements, and provisions for accessibility. In contrast, major maintenance is a planned activity of facilities renewal funded by the annual operating budget. Failure to perform needed repair, maintenance, and renewal as part of normal maintenance management creates deferred maintenance.

5.4 Adaptation/Renovation/Modernization

The improvement, addition or expansion of facilities by work performed to change the interior alignment of space or the physical characteristics of an existing facility so it can be used more effectively, be adapted for new use, or comply with existing codes. Includes the total amount of expenditures required to meet evolving technological, programmatic or regulatory demands.

Space modifications to accommodate program needs, sometimes called *program improvements* or *alterations*, are often overlooked in budgeting for facilities needs. It is common to use maintenance funds as the only available source for improvements. Thus, erosion in facilities maintenance results from this practice. A preferred practice is to set up a specific budget line item for functional improvements and to attempt to coordinate major maintenance projects into planning. For example, a revision to a suite of laboratories could include replacements for heating, ventilation, and air conditioning (HVAC); electrical systems; and plumbing systems, creating a project with a larger scope than the space modification project.

5.5 Facility Condition Index

The current facility condition index can be accurately calculated using the total estimated cost for all deferred maintenance deficiencies (DM) and the current replacement value (CRV) of the facility. The facility condition index, or FCI, is defined as follows; $FCI = DM/CRV$



Using an accurate Facilities Condition Index and the Current Replacement Value it is possible to model the cost of achieving contemplated future facilities conditions. To provide realistic budgeting of the costs, we must also consider inflation, facility growth, plant deterioration and deficiency deterioration. It should be assumed that existing deficiencies will deteriorate faster than components in good repair.

5.6 Facility Condition Audit

The FUSION Facilities Condition Assessment is a good starting point but has some limitations. A comprehensive inspection of the facilities by a multi-discipline team should be considered essential to provide appropriate planning information and accurate benchmarking. The team should include architects as well as structural, mechanical and electrical engineers. The inspection team can be district personnel, consultants, or a combination. Having developed a database of deferred maintenance deficiencies and future component replacement, it is then necessary to estimate the cost, in current dollars, of repairing these deficiencies, or replacing the equipment or systems.

The data regarding the deferred maintenance should include identification of building component and sub-component; a sequential reference number and deficiency rating, location and description and, a deficiency repair cost. Future component renewal costs will be allowances rather than specific costs.

6.0 Maintenance and Operations

6.1 Preventive Maintenance

Preventive Maintenance consists of a series of maintenance requirements that provide a basis for planning, scheduling, and executing scheduled maintenance, planned versus corrective for the purpose of improving equipment life and to avoid any unplanned maintenance activity/minimize equipment breakdowns. These can be defined through a Maintenance Plan (MP). PM includes adjusting, lubricating, cleaning, painting, and replacing minor components. Time intensive PM, such as bearing/seal replacement, would typically be scheduled/planned for regular plant or 'line' shutdown periods.

6.2 Maintenance Plan

The purpose of a Maintenance Plan is to describe the best means to maximize equipment operational availability, while minimizing equipment downtime. Once developed, the MP will typically identify PM



task descriptions and schedules, troubleshooting, corrective maintenance (repair) task descriptions, and spare parts identification, stock (quantity), and any unique storage requirements. This information will be incorporated in the manual, both as tabular data and text.

Preventive maintenance (PM) data includes equipment tag information, procedures, replacement parts, special tools, lubrication requirements, service providers, warranty information, etc. It is often presented in tabular format in the O&M manual. With BIM implementation, this data can be initially entered via Construction Operations Building information exchange (COBie) between the design construction and operations phases of a project, then transferred to (versus input directly into) PC-based Computerized Maintenance Management System (CMMS) or Computer-Aided Facilities Management (CAFM) software applications.

The collection of data can start early in the process as it has been identified that up to 48% of the data is available at the 100% design phase. Stretching out the process avoids the tsunami of information at handover. The BIM should be used for commissioning then the information can be provided immediately for use for O&M the day the facility opens. Using the National BIM Standard-United States™ open information standards will help ensure you are not locked into any one vendor and you can use any product that supports the open standard for BIM.

CMMS/CAFM applications typically support facility management needs associated with personnel, leasing, furniture, construction, equipment (including fleet vehicles), labor, spare parts inventory (with bar coding), PM scheduling, Work Order generation, and associated costs tracking. There are literally hundreds of these applications available today, which can be evaluated to identify the most appropriate. The CMMS/CAFM products should have the ability to be tailored to Owner-specific requirements.

6.3 Operations and Maintenance Manual

O&M Manuals provide procedures to operate and maintain a facility's various systems and equipment. It is important to analyze and evaluate a facility from the system level, then develop procedures to attain the most efficient systems integration, based on as-built information and the Maintenance Program philosophy.

The O&M Manuals should be prepared on a System-Level format as follows:

Introduction: Introduces the reader to the facility. Outlines the structure, content, how to use the manual, and includes a brief outline of the various systems covered. In addition, this chapter contains a list of emergency contacts and a list of supplementary material available on the facility such as:

1. Design/Construction Specifications



2. Submittals File
3. Completion Report
4. As-built Drawings
5. Materials List
6. Certified Tests and Reports
 - a) Civil/Sanitary
 - b) Mechanical/HVAC
 - c) Electrical
7. Safety Data: Safety hazards commonly associated with the operation of system/equipment applicable to the facility are identified and their prevention is discussed.
8. Utility Systems: Discusses the various site utility systems that interface with the facility. These include water supply systems, sanitary waste, electrical, natural gas, communications, security, and storm water, etc.
9. Building Interior & Exterior: Includes housekeeping and general maintenance of the facility. The importance of conduction and annual inspection is discussed together with record keeping forms for conducting the inspections.
10. Plumbing: O&M of the domestic water and sanitary waste systems.
11. Fire Protection: O&M of the fire protection wet/dry pipe sprinkler systems.
12. Heating, Ventilating & Air Conditioning (HVAC): O&M of the building's HVAC systems, including automated controls and exhaust, space heating, and central air systems.
13. Fire Detection & Intrusion Alarms: O&M of fire detection and intrusion detection and alarm systems (wet/dry pipe sprinkler).
14. Electrical: O&M of power distribution equipment and backup/emergency electrical systems (uninterruptible power supply, generator).
15. Conveying Systems: General information and preventive maintenance for elevators, escalators, wheel chair lifts, conveyors, etc.
16. Other Systems Based on Facility Requirements: General information and preventive maintenance requirements for other systems and equipment not already identified.
17. Operating Logs: General information and instructions for using maintenance log forms. A listing of maintenance tasks with their recommended frequencies of performance is included.
18. Maintenance Charts: Maintenance charts include maintenance frequency checklists, maintenance summary, lamp replacement data sheet, equipment data sheets, recommended maintenance and service contacts, and a recommended work order form.
19. Manufacturers' Literature: Identifies manuals, cut sheets, etc., from equipment manufacturers that amplify information provided within the system-level O&M manual. Manufacturers' literature generally provides procedures to operate, maintain, troubleshoot, and repair specific



items at the equipment level. This information is contained in a separate volume of binders, identified by facility/system, for easy reference. Specific material or complete documents can also be electronically scanned for its 'on-line' use, such as linking from the system-level manual.

System-Level O&M Manual Technical Content/Description

1. Description - System-Level: Description of the system and its purpose, how it operates, and any interfaces it may have. A table can provide overall system design criteria, i.e. flow, pressure, temperature, capacity, power requirements, etc.
2. Operating Procedures - Controls/Start-up/Shutdown/Emergency Over-Ride/Seasonal Changeover: Operating instructions include equipment configurations for each mode of operation, e.g. valve positions, control settings, intended operating strategies, and break-in procedures.
3. Problems and Solutions - Troubleshooting: System-level troubleshooting tables guide maintenance personnel, via fault tree analysis, in a sequential, step-by-step isolation of a system problem to identify faulty equipment. Typical malfunctions, tests or inspections, and corrective actions or recommendations to correct malfunctions are included.
4. Preventive (Planned) Maintenance (PM) - Procedures/Intervals: Maintenance tasks are developed for equipment that comprises the system. Preventive and corrective maintenance is discussed. Scheduled intervals (e.g., daily, weekly, monthly, etc.) are determined and assigned to PM tasks to maximize systems run time, thereby reducing corrective maintenance tasks.

Figures/Illustrations

Operation-/ maintenance-significant figures/illustrations should be included in the manual and referenced from the narrative text. Illustrations can provide the layout of the overall site-campus/facility/floor down to systems/equipment and area/room locations. They can be generated for O&M Manual use from BIM/3D models and engineering drawings that are modified for ease of readability in the manual. They typically include the following:

1. Area floor plans with system/ equipment tags and physical (room) locations identified.
2. Safety warnings and cautions regarding potential hazards, both to personnel and to equipment.
3. Photographs of systems/equipment with identifying callouts.
4. Electrical schematics, piping diagrams, air flow schematics, provide equipment interconnections and are important for troubleshooting.
5. Valve schedules indicating valve number, location, type, size, normal position, and description.

Electronic Formats



The elements of narrative text (pdf, html, xml, etc.), graphics including BIM, sound, photographs, and videos can all be organized into a user-friendly, interactive, stand-alone PC or web-based (e.g., Intranet) application or platform.

For O&M manuals, it is often referred to as the Interactive Electronic Manual (IEM), for training materials, Computer-Based Training (CBT). Similar to this document, text and graphical information is typically linked to related data within the O&M manual, or to external sources such as an Owner's intranet or the internet, accessed by a click of the mouse. One caution relative to linking to internet sources is that of security. The Owner's information technology (IT) department should be consulted in these instances.

Screens can be printed on demand. All information, including text, BIM / 3D models / animations, CAD drawings, illustrations, and digital photographs can be viewed and manipulated (read only) by on-line viewers and can only be modified off-line. Updates/modifications are typically through a configuration management process and formal authorization.

Typical Task Performance based on the owner's SOW/scope requirements and maintenance philosophy:

Perform a review and extract as-built information from engineering data such as the basis of design, specifications, as-built drawings, and submittals, vendor/manufacturer documentation, site visit(s), etc., to prepare a comprehensive facility maintenance plan.

Organize and develop information into a clear and concise system-level O&M manual.

1. Physical Descriptions
2. Functional Descriptions
3. Troubleshooting
4. Preventive Maintenance (procedures and schedules)
5. Corrective Maintenance (repair requirements)
6. Parts Lists
7. Organize and tailor scanned / electronic versions of graphical information (e.g., CAD drawings, BIM/3D models, illustrations, digital photographs, etc.) to support text.
8. Compile warranty information.
9. Compile spare parts lists.
10. Enter pertinent data via COBie for its transfer into the owner's CMMS or CAFM application for use by the operation and maintenance staff.
11. Create equipment-specific O&M information (vendor/manufacture data) library.
12. Develop training plan, student/instructor guides, presentation materials, etc.
13. Develop IEM/CBT.



Appendices

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- I. CCSF Sustainability Plan for Construction, Retrofitting and Operations Part 1 December 17, 2009

 - II. CCSF BIM Standard - Draft

 - III. CCSF Total Cost Of Ownership Dashboard

 - IV. 2013-03-12-COBieGuide-Public, Dr. Bill East, PhD, PE, F.ASCE, Mariangelica Carrasquillo-Mangual





Sustainability Plan Part 1

For Construction, Retrofitting, and Operations

December 17, 2009

City College of San Francisco

Sustainability Plan Part 1

For Construction, Retrofitting, and Operations

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Acknowledgements

The Sustainability Plan was made possible through the hard work and/or advice from the following individuals and committee members:

Edward Amoah,	Management Assistant, Facilities Planning & Construction
Julia Bergman,	Librarian and System Administrator
James Blomquist,	Associate Vice Chancellor, Facilities Management
Anna-Marie Bratton,	Laboratory Manager, Department of Biology
Joe Cannon,	Instructor, Department of Biology
Kristin Charles,	Dean of Grants & Resource Development
Virginie Corominas	CCSF Student
Erika Delacorte,	Instructor, Department of ESL
Josefina De Lara,	Management Assistant, Facilities Management
Marcella Enos,	Assistant Professor, College of Technology, Idaho State University
Dr. Stephen Edwini-Bonsu,	Sanitary Engineer, San Francisco Public Utilities Commission
Anastasia Fiandaca,	Counselor, Latino Services Network
Dr. Robert Gabriner,	Vice Chancellor of Institutional Advancement
Peter Goldstein,	Vice Chancellor of Finance & Administration
Michelle Gorthy	Instructor, English Department
Kathy Hennig,	Purchasing Manager
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Larry Lauser,	Senior Building Inspector, Facilities Planning & Construction
Brian Leong,	Senior Engineer, Building and Grounds
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Deborah Levy,	Instructor, Department of ESL
Peggy Lopipero-Langmo,	Instructor, Department of Biology
Susan Lopez,	Office of Research & Planning
Kaya MacMillan,	CCSF Student, United Sustainability Alliance
Michael Manneh,	Teaching Assistant, Southeast Campus
Milton Marks,	Board of Trustees
Carlita Martinez,	Recycling Coordinator
Charles Metzler,	Instructor, Computer Science
Pamela Mery,	Office of Research & Planning
Gohar Momjian,	Office of Research & Planning
Madeline Mueller,	Chair, Music Department
Carolyn Norris,	Human Resources
Muriel Parenteau,	Chair, Parking & Trans. Committee
Craig Persiko,	Instructor, Computer Science Department
Dr. Vera Pitts,	Professor Emerita, California State University, Hayward
Crima Pogge,	Instructor (Biology), Center for Habitat Restoration
Ildiko Polony,	CCSF Student, The Bikery
John Rizzo,	Board of Trustees
Dr. Alysson Satterlund,	Special Assistant to the Chancellor
Natalie Sierra,	Civil Engineer, San Francisco Public Utilities Commission
Lia Smith,	Instructor, Department of ESL
Jana Zanetto,	Instructor, Department of ESL

Members of the College Advisory Council: Darlene Alioto, Lena Carew, Attila Gabor, Dave Gallerani, Gus Goldstein, Peter Goldstein, Don Griffin, Linda Grohe, Hal Huntsman, Donald Lind, Alice Murillo, Josh Neilsen, Mark Robinson, Athena Steff, Ryan Vanderpol

Members of the Planning and Budgeting Council: Christian Crespo, Carlota Del Portillo, Attila Gabor, Richard Gale, Dave Gallerani, Peter Goldstein, Don Griffin, Maria Heredia, Marc Kitchel, Donald Lind, Susan Lopez, Paolo Marquez, Madeline Mueller, Alice Murillo, Josh Neilsen, Stephanie Nuttman, Francine Podenski, Karen Saginor, Athena Steff, David Yee

Executive Summary

In May of 2006, Board Resolution “Sustainability Efforts at City College of San Francisco” directed the College to create a Sustainability Plan, including specific tasks and implementation and reporting schedules.

The need for all colleges and universities to reduce their impact on the environment is undeniably apparent. Like other public education counterparts, community colleges are taking steps to reduce their carbon footprints, their generation of solid waste, and other negative impacts on the environment. Recognizing the relevance of environmental concerns to our educational mission of service to the community, the Board of Trustees expressed interest in sustainability policy at CCSF as early as 1996. The Overview of this document describes major milestones along this pathway. Significant leadership in sustainability at CCSF is being taken by the Board and the Chancellor, by students, faculty, staff and administrators---truly a college-wide mandate and collective effort.

CCSF’s Sustainability Plan is published in a two-part format. Part 1 of the plan addresses sustainability in construction and retrofitting, as well as in day-to-day operations (e.g., purchasing, landscaping, transportation). This document sets out policies and programs and for managing resources, at and for all CCSF campuses, using a sustainability approach. Management resource principles emphasize prevention of impact over mitigation after the impact. Many valuable resources, ideas, and standards have been brought together in this document, with the help of community input, to provide an indispensable framework for sustainability in operations and facilities. It can be found online at the following link where it will serve as a guide for the CCSF and the community: http://www.ccsf.edu/Offices/Research_Planning/pdf/SustainabilityPlanPart1Dec09.pdf.

Part 2, published separately, addresses in a sustainability context the following areas: education (curriculum, green careers and partnerships, workforce development); commitment to sustainability (environmental awareness of students and employees, staff development, communicating to the community the CCSF commitment), student services, and social and economic sustainability.

The CCSF Sustainability Plan will include the normal cyclical elements of planning, budgeting, implementation, and evaluation. Several sustainability efforts planned in this document have already begun and that some are on-going as of the time of its publication. Parts 1 and 2 of the Sustainability Plan will be followed by specific implementation planning, which will include timelines, the prioritization of the most critical tasks in each time period, and assignment of responsibility to given individuals and units. Links with the budgeting system will be established through the College's annual planning and budgeting process, which will include the vigorous exploration of various funding sources. The College will of course base its facilities development, as well as all of its efforts on educational, environmental, social and economic fronts, on a rational exploitation of its resource base in keeping with the goals of this Sustainability Plan.

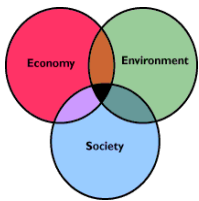
Various means of evaluation for implementation of the Plan will also be developed in further detail as part of specific action plans. Based on results of those assessments, the cycle of planning and implementation will continue so that the necessary adjustments and improvements can take place.

CHAPTER 1 OVERVIEW

Background

City College of San Francisco (CCSF) has 3,500 faculty and staff and serves a diverse community of over 100,000 students. With its focus on retraining and workforce development, on immigrant education lifelong learning, on second chance opportunities and preparation for transfer, CCSF is uniquely situated to promote education for sustainability to a broad audience.

For over 70 years, the College has served the educational needs of the City and its environs in the truest populist tradition. The College, one of the largest community colleges in the country, has 10 campuses located throughout the City of San Francisco. The main campus, Ocean Campus, is located in the southwestern part of the City. On all of its campuses and at all sites, the College takes seriously the responsibility of exemplifying environmental awareness and responsibility in its operations and educational services.



The Chancellor and CCSF Board of Trustees have encouraged everyone at the College to share in the responsibilities of citizenship and service in the global community. In December 1996, the Board of Trustees adopted a policy (PM 7.22, Facilities) relating to sustainability (including solid waste management; hazardous materials; conservation and air quality; transportation; purchasing; grounds-keeping; facilities; and curriculum, education and staff development). In 2003, the College adopted a Master Plan (MP) which serves as a guide for development of all new facilities and renovation of existing facilities. An Environmental Impact Report (MPEIR) was prepared per the requirements of California Environmental Quality Agency (CEQA) in 2004, which identified the potential environmental impact of all the projects and provided recommendations for mitigating these impacts. In 2005, the College joined the Association for the Advancement of Sustainability in Higher Education (AASHE).

In May 2006, the Board of Trustees passed Resolution 060525-S3 mandated, among other things, the creation of this Plan. In Spring 2007, a Shared Governance Sustainability Committee was created, with students, faculty, staff and administrators appointed by their constituencies. In February 2007, a Sustainability Prospectus was circulated by college-wide email to all employees. The purpose of the prospectus was to propose a CCSF sustainability initiative that would address not only environmental sustainability but also social and economic sustainability.

This first part of the College Sustainability Plan focuses on such endeavors as the following, as they relate to sustainability:

- Green principles in the planning, design, and construction of new buildings and facilities;
- Environmentally appropriate renovation projects and retrofits;
- Sustainable college operations, maintenance and custodial operations;
- Sustainable purchasing practices and procurement of local materials;
- Waste diversion, management and recycling activities;
- Water conservation measures;
- Restoration of natural elements such as vegetation;
- Environmentally friendly transportation policies;
- Energy conservation and onsite and offsite renewable energy opportunities.

Commitment to Sustainability

Higher education is increasingly incorporating sustainability as a societal value and ideal, regarding it as a natural and essential element within the educational mission. A sustainable society meets the needs of the present without sacrificing the ability of future generations to meet their own needs. Put simply, sustainability requires that we limit our negative impact on the natural, social, and economic environments, while at the same time positively impacting these environments.

Environmental sustainability is a cornerstone of Part I of this Plan, which contains many strategies that will greatly enhance our environment, including some exciting programs which have already been initiated. It also strongly underpins the educational programs, staff development and other content in Part 2.

Social and economic sustainability are addressed in Part 2, which also continues to plan for further environmental sustainability. As a whole (Parts 1 and 2), this Plan will become a roadmap for the College to take responsible and farsighted measures that will have positive local, regional, and global impact for many years to come., e.g., in the following areas:

- (i) Maintaining a college environment that is sustainable in social, environmental and economic terms, expanding the incorporation of sustainable practices into day-to-day operations and environmentally friendly transportation practices;
- (ii) Continuing to expand the use of sustainable practices in the planning, design and construction of all new facilities and retrofitting of existing facilities to provide superior quality campus environment for all faculty, staff, students and the community;
- (iii) Educating faculty, staff and administrators about their roles in maintaining a safe and healthy environment for the present and future generations;
- (iv) Communicating our commitment to sustainability to students and the community;
- (v) Incorporating the value of sustainability into student services;
- (vi) Infusing sustainability throughout curricula; and
- (vii) Preparing students for new careers and providing work experience related to sustainability.

The CCSF Sustainability Plan Part 1 for Operations, Construction, and Retrofitting will primarily address (i) and (ii) in the above list. The remaining objectives will be addressed in the CCSF Sustainability Plan Part 2 for Education.

Purpose of the Sustainability Plan

Part 1 of the Plan presents the guidelines for the long-term development and operation of sustainable campuses. It is intended to be used as an educational resource for all offices, departments, and Shared Governance bodies. It will serve as a guide for all employees involved in planning, design, construction, operations, maintenance and deconstruction activities, and procurement of all materials, supplies and equipment. Like all CCSF plans, Parts 1 and 2 of the Sustainability Plan rest on the Mission Statement of the College. They will make explicit the intention of the Strategic Plan to meet the needs of the community in a socially, environmentally and economically responsible way.

Disclaimer/Limitations

The Sustainability Plan does not contain comprehensive listings of federal, state and local regulations pertaining to specific programs and projects. Every effort has been made to identify corresponding local, state and federal requirements, codes, laws and regulations. This document cannot be used as a substitute for all applicable codes, laws and regulations.

Funding

The cost of sustainable construction practices (described in Chapter 2) for new and renovated buildings will be included in the construction budgets, and will come from voter-approved bonds, including the 2001 and 2005 bonds, as well as state construction funds.

Funding for sustainable operations (described in Chapter 3) will occur in a combination of ways. Some sustainability measures involve no additional cost to the College and may even result in additional cost savings. Some efforts can be funded through reallocation of resources; a good approach when an initial investment can yield a net savings. The following additional revenue strategies can be pursued:

- ◆ Aggressively research and pursue all possible sources of funding, such as donations and grants, to develop, establish and promote these sustainability initiatives.
- ◆ Redeem the recovery value for all recyclable and compostable materials collected on college campuses and sites.
- ◆ Designate any additional monies or savings gained from implementation of that or other sustainability strategies to fund future sustainability projects instead of returning that revenue or savings to the District's general fund.
- ◆ Assess students an optional Green Fee, payable at registration, to help fund sustainability work.

Implementation

All of the objectives of the Sustainability Plan will be met by the year 2018. Some of the objectives of the Sustainability Plan are already being implemented or in the planning stages. Others will be implemented through resolutions at the Board of Trustees and action by the administration.

Refer to the Implementation Table (Appendix 1, Page 29) for all objectives and timelines.

Evaluation of Implementation Activities

Whenever possible, evaluation of implementation activities will determine the environmental, social and economic impacts of the measures implemented. The College will develop baseline data and adopt metrics by which to monitor progress. In some instances, a metric may be specified by law or regulation. The Office of Facilities Planning and Construction, along with the Office of Buildings and Grounds, will present to the Board of Trustees or its committees annual reports of new sustainability initiatives as well as progress towards sustainability targets. All such reports will also be made available to the community.

CHAPTER 2: SUSTAINABILITY REQUIREMENTS FOR CONSTRUCTION PROJECTS

Selection of Project Team

The Requests for Qualifications/Proposals (RFQ/RFP) for design and construction teams on each project will mention sustainable building design and construction. The criteria by which the design and construction firms will be measured will include experience/qualifications relating to sustainability. The CCSF Sustainability Plan Part 1 will be included in all RFPs/RFQs sent out to prospective design and construction teams.

Selection of Green Building Standards

Four environmental rating systems were reviewed in the development of this Plan:

- ◆ The United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Rating System for New Construction, Major Renovation Projects and the Existing Buildings,
- ◆ Collaborative for High Performance Schools (CHPS) Best Practices Criteria,
- ◆ United Kingdom Building Research Establishment Environmental Assessment Method (BREEAM) for schools,
- ◆ Green Globes Design Environmental Assessment for New Buildings and Green Building Challenge.

The USGBC LEED Rating system was selected for all College projects because most design and construction professionals are more familiar with the LEED rating system than all the other models. The LEED model was also developed from the BREEAM model, the first and oldest green model. The Sustainability Plan also incorporates some standards and practices from the other specifications that are not contained in LEED.

Since drafting this document, the City of San Francisco and the California legislature have put in place new local and state requirements for all new construction and major renovation projects which the College must follow.

Conceptual Design to Post Construction

The CCSF goal for all new and future construction projects, major renovation projects, existing building operations and upgrades will be to attain at a minimum a LEED silver rating or higher according to the latest LEED standard.

- The CCSF goal will be to comply with Chapter 7, Section 705 and 706 of the City of San Francisco's Environment Code Resource Efficiency Requirements, whether such projects are registered for certification or not;
- All capital project teams will review the College Sustainability Plan and information in the College Sustainability Tracking Database. The teams will use the College's Sustainability Scorecard provided in the Plan as a guide to research and incorporate creative measures to establish goals and achieve a project sustainability standard equal to LEED Silver Rating or higher;
- Where applicable, each project team should include a commissioning agent licensed through the California Commissioning Collaborative to help coordinate the sustainability concepts in the conceptual and construction phases of the project;
- Project teams will quantify and track the progress of sustainability goals set for the project from the design through the construction phase;
- During construction, the project teams will develop and implement a systematic commissioning plan to ensure that the energy and atmosphere goals and operational requirements of the project are attained; and will verify installation and performance of systems, provide training, operation and maintenance documentation, and may be required to train the College's maintenance staff;

- Construction teams will complete a commissioning report along with a 'project mission accomplished' report which will include a summary of sustainability goals accomplished, design and construction challenges encountered, strategies to tackle these challenges, critical success factors, failures, lessons learned and successes. This information will be used to update the College's Sustainability Tracking Database;
- Project teams will finalize all as-built project information and the College may develop and implement additional commissioning requirements to ensure that all commissioning related matters are resolved within one year after construction completion;
- During project handing over, construction teams may be required to provide building occupants with facility tour and informational sessions on building systems and recycling and other matters.

Mitigation Monitoring and Auditing Program for Master Plan Projects

Objective To reduce the environmental impact resulting from the construction of the Master Plan projects

Activities Institute the appropriate monitoring and reporting program for mitigation measures identified in the Master Plan Environmental Impact Review Report (MPEIR). The components of the program will include the following:

- Summary of significant impacts identified in the MPEIR
- Mitigation measures recommended for each impact
- Monitoring requirements for each mitigation measure
- Timelines and monitoring frequency
- College Department responsible for monitoring and reporting

Perform periodic environmental audits to resolve actual or potential compliance problems.

Sustainability Tracking Mechanism

CCSF will develop a project reporting system to track the planning, design, construction and post construction, and occupancy phases of all projects. The system will be used to track design and construction challenges encountered, strategies used to tackle such challenges, critical success factors, lessons learned and successes. This application will be designed to be interactive and will be a knowledge-base for all staff involved in any aspects of planning, design, construction, post construction and/or maintenance of projects. The system will provide the framework for continuous learning and improvements and will serve as the performance evaluation tool for sustainability initiatives and building systems. The College will require all prospective construction professionals associated with any phase of the project to review this information. Parties awarded any phase of the project will be asked to abide by these conditions.

College Facilities Standards

CCSF will review and improve its current campus standards to outline required products and mandatory design constraints for all construction on College campuses. The standards will be complimentary to specific project requirements and may be modified at the discretion of the College's Representative. The standards are not meant to dictate design solutions, as this is the function of each project's design professional. The standards will provide the College with functional and durable buildings based on experience with existing campus buildings, systems, products and materials used.

Sustainable Sites

The College is cognizant of local and federal laws and will comply with specified regulations related to Sedimentation and Erosion Control, Selection of Sites, and other relevant laws pertaining to Sustainable Sites.

Reduced Site Disturbance

Objective To conserve existing natural areas, restore damaged areas, provide habitat and promote biodiversity

Activities The College's Master Plan presents plans and recommendations for the long-term development of all campuses. Selected project locations and designs will have minimal footprint to reduce site disruption. Established construction boundaries will be clearly marked to minimize existing site disturbance and restore previously degraded areas to their natural state. Site disturbance including earthwork and clearing of vegetation will be limited to 40 feet beyond building perimeter, 5 feet beyond primary roadway curbs, walkways, and main utility branch trenches, and 25 feet beyond pervious paving areas that require additional staging areas and a minimum of 50% of remaining open area will be restored with native or adapted vegetation.

Development footprint

Development footprint (including building, access roads and parking) will be reduced to exceed local zoning's open space requirement for project site by 25% where possible. CCSF will consider multi-story buildings within the limits of San Francisco zoning restrictions to reduce the size of land required for construction, where this is cost effective and feasible.

Landscape and Exterior Design to Reduce Heat Islands

Objective To reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat

Activities Thirty percent or more of non-roof impervious surfaces including parking lots, walkways, and plazas will be shaded with landscape features to minimize the overall building footprint. The College may specify and use ENERGY STAR roof-compliant, high-reflectance and high emissivity roofing to reduce heat absorption. "Green" (vegetated) roof may be installed for at least 50% of the roof area if considered feasible.

Light Pollution Reduction

Objective To eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments

Activities CCSF will adopt a site lighting criteria to maintain safe light levels and avoid off-site lighting and night sky pollution. The Illuminating Engineering Society of North America (IESNA) foot-candle level requirements stated in the Recommended Practice Manual: Lighting for Exterior Environments will not be exceeded. Site lighting may be modeled using a computer simulation to determine the minimum site lighting where possible. The College will consider other technologies used to reduce light pollution such as full cutoff luminaires, low-reflectance surfaces, and low-angle spotlights.

Plan for Green Site and Building Exterior Management

Objective To encourage grounds/site/building exterior management practices that have the lowest environmental impact possible, and to preserve ecological integrity, enhance diversity and to protect wildlife while supporting building performance and integration into surrounding landscapes

Activities The College will institute a low-impact site and green building exterior management plan to address overall site management, chemical/fertilizer/pest management and building exterior cleaning and maintenance practices. This plan will include the following:

- Green cleaning materials/chemicals (with list of certified vendors/manufacturers), and maintenance practices with minimal environmental impact.
- Green landscape practices which focus on using native plants, reducing size of lawns, changing maintenance practices, reducing the use of power equipment, storm-water control, minimal use of fertilizers, composting waste, applying integrated pest management, avoiding/removing invasive plants, protecting natural areas and using plants to reduce heating and cooling needs.
- Integrated Pest Management (IPM) for safe, effective and economical pest control management.

- Other Activities such as using mulching mowers to reduce yard waste generation, fertilizer needs and water consumption through retention of organic matter.

High Development Density Buildings and Areas

Objective Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources

Activities CCSF will give preference to occupying high development density buildings in urban locations with high development density

Existing Buildings Only

In addition to the above strategies for all projects, the following will apply to the operating performance and upgrading of existing buildings:

Age of Building

Objective To provide a distinction between buildings considered for new construction certification and buildings that are eligible to apply existing building certification. The CCSF goal for the operating performance and upgrades of all buildings two years and older will be to seek to attain LEED-Existing Building Silver Rating or higher, 43+ points.

Activities Sustainable operations and maintenance strategies will be developed and implemented.

Water Conservation

Governor Schwarzenegger has put forth a goal of 20 percent reduction in water use by 2020. City College will meet or exceed this 20 percent reduction goal through the use of the construction standards described in this section, and by implementing the practices described in Chapter 3.

Water Appliance Standards in New and Remodeled Buildings

All new and replacement plumbing fixtures shall meet or exceed federal water conservation standards. Plumbing fixtures shall be upgraded to these standards when any part of a building is remodeled or renovated, as follows:

1. New toilets: All toilets installed in new facilities or new restrooms shall be high efficiency models that are rated at 1.28 gallons per flush or lower.
2. Replacement toilets: When a building is being remodeled, all toilets in the building that have a flush volume of 3.5 gallons per flush or greater will be replaced by high efficiency models that are rated at 1.28 gallons per flush or lower. However, in the case of older buildings with sewage slope lines that are below modern standards in terms of pitch, toilets of 1.6 gallons per flush may be used.
3. Urinals: All urinals installed in new or remodeled facilities or restrooms shall be high efficiency models that are rated at 0.5 gallons per flush or less. Waterless urinals may also be used.
4. Sinks: New and replacement faucets and faucet aerators shall have a maximum flow rate of 1.5 gallons per minute at a flowing water pressure of 60 pounds per square inch. Gooseneck faucets will be installed.
5. Autoflush appliances: The College will not install automatic flush toilets and urinals or motion-activated sinks. Any existing automatic water appliances will be replaced when the building is remodeled
6. Showerheads: All showerheads shall be low-flow devices having a maximum rated flow of not more than 2 gallons per minute at a flowing water pressure of 80 pounds per square inch. Showers shall not have more than one showerhead per stall.

Leak Testing and Repair

The College will initiate a program to test all buildings district-wide for leaks. Any building undergoing any amount of renovation or modification will be tested for leaks. All buildings will be tested for leaks by the year 2013. Leaks will be repaired within 90 days of detection.

Water Efficient Landscaping

Objective To minimize or eliminate the use of potable water for landscape irrigation

Activities Landscape design and water use will conform to the water efficient landscape ordinance outlined by the California Department of Water Resources Model Ordinance. To reduce or eliminate the need for irrigation, soil/climate analysis will be performed to determine appropriate landscape types and design for each landscaping project and drought-tolerant plants and shrubs will be specified. Other measures will include installation of high efficiency and/or temporary irrigation systems in areas that may require irrigation and artificial turf for active play areas and fields. Permanent irrigation systems that are not high efficiency will be avoided, and CCSF will continue to research the possibility of using municipally supplied reclaimed water for irrigation.

Stormwater Management Infrastructure

Objective To reduce negative impact on water and air quality by increasing on-site infiltration, minimizing storm-water runoff, and reducing contaminants during and after construction

Activities To meet stormwater compliance requirements and to minimize and/or prevent sediments from entering the combined sewer system, CCSF will follow the best management practices outlined by the State Water Resources Control Board and will comply with the 2003 EPA Construction General Permit (CGP). The project site will be designed to maintain natural storm-water flows and to improve infiltration. Pervious paving will be specified and used to minimize impervious surfaces. Where possible, stormwater may be collected and used for non-potable uses such as landscape irrigation.

For construction area of 1 acre or greater, CCSF will apply for the Construction General Permit. Techniques such as the installation of a sedimentation tank will be used to collect and pre-treat storm-water before discharging into the City's combined sewer system for further treatment. The College will follow the requirements of the San Francisco Bay Regional Water Quality Control Board for post construction stormwater management practices. Techniques to be employed will include but not be limited to reduced use of impervious surfaces, installation of porous pavements, filtration basins and trenches, and grassy swales.

Energy

Minimum Energy Performance

Objective To establish the minimum level of energy efficiency for proposed building and related systems

Activities The building envelope and systems for new construction and major renovation projects will be designed to maximize energy performance and to exceed the Title 24 - 2007 California energy efficiency standards by 10%. Computer simulation model will be used to assess energy performance and to identify the most cost effective energy efficiency measures. This will be compared to the Title 24 - 2007 baseline building. For existing buildings, annual electricity bill, including cost and usage amounts will be analyzed to identify energy savings opportunities. Energy-efficiency retrofits and energy-saving techniques will be implemented to reduce energy use to meet this goal.

CFC Reduction in HVAC&R Equipment

Objective To reduce ozone depletion

Activities For existing HVAC systems, inventories will be conducted to identify equipment that uses chlorofluorocarbons (CFC) refrigerants and CCSF will adopt a schedule to replace these refrigerants. For new buildings, new HVAC equipment with zero use of CFC-based refrigerants will be specified.

Optimize Energy Performance

Objective To achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use

Activities Building envelope and systems will be designed to maximize energy performance. Computer simulation models will be leveraged to assess the energy performance and to identify the most cost effective energy efficiency measures. Regulated energy components will include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by the American Association of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) (see details at www.energycodes.gov/implement/determinations.com.stm). Energy performance will be quantified and compared to a baseline building. Sensors for lighting will be repaired and/or replaced throughout the College. For existing buildings, energy-efficiency retrofits and energy-saving techniques will be implemented to reduce energy use to the level required to meet this credit.

Renewable Energy

Objective To encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use

Activities All new and future projects will be assessed for renewable energy potential including on site solar and wind strategies along with other savings by design programs being offered by local utilities agencies and third party financing options.

The performance of the system will be evaluated from the annual energy output using the Department of Energy (DOE) Commercial Buildings Energy Consumption Survey (CBECS) database as a guide to determine the baseline electricity use. If any of these above stated strategies are employed, CCSF will take advantage of the net metering with the respective local utility agency.

The College will evaluate the electrical consumption trends on all existing buildings and will identify opportunities for using renewable energy sources. Where such opportunities can be exploited, CCSF will work with the local utility company and/or other renewable power companies to guarantee credit from fraction of electric power derived from net non-polluting renewable technologies.

The College will engage in a green power contract with local utility agencies where such opportunities exist and when considered viable.

Additional Commissioning

Objective To verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended

Activities The College will contract with a Commissioning Authority (CA) during the design phase of a project to conduct project reviews before, during, and after construction documents are complete; develop a commissioning manual for the building and review project at near-warranty end. For projects considered for certification, CA will be involved in the early planning and design phase of the project.

Ozone Depletion and Additional Ozone Protection

Objective To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to global warming

Activities For all new construction and renovation projects, refrigeration and fire suppression systems that use no HCFCs or halons will be specified and installed. For existing buildings, inventory of existing systems using refrigerants and fire suppression chemicals will be taken and systems containing CFCs, HCFCs or halons will be replaced accordingly.

Performance Measurement, Verification and Enhanced Metering

Objective To provide for the ongoing accountability and optimization of building energy and water consumption performance over time, and add incentives for additional energy reduction

Activities For all new construction and renovation projects, energy and water systems will be modeled to determine potential savings. Buildings will be designed and equipped with the appropriate systems to measure energy and water performance. Building performance plans will be developed and implemented during building operations to monitor predicted savings.

For existing buildings, items listed above will be metered where possible and CCSF will develop and implement a program to evaluate and improve their performance over time. International Performance Measurement and Verification Protocol (IPMVP) Volume I: Concepts and Options for Determining Energy Savings may be used to track energy savings of specific energy-efficiency measures implemented in buildings.

Sustainable Building Cost Impacts Documentation

Objective To document sustainable building cost impacts and select a lifecycle cost model for determining the lifecycle cost of any new facilities.

Activities Sustainability Tracking Mechanism

CCSF will design a project reporting system that can be used to track the planning, design, construction and post construction, and occupancy phases of all projects, along with challenges and successes experienced on each project. This application will be designed to be interactive and will become a knowledge-base for all staff involved in all aspects of planning, design, construction, post construction and/or maintenance of projects. The system will provide the framework for continuous learning and improvements and will serve as a performance evaluation tool for sustainability initiatives and building systems. Building operating costs will be reviewed periodically to identify any positive impacts relative to sustainable performance improvements to building systems and operations.

Existing Building Commissioning

Objective To verify that fundamental building systems and assemblies are performing as intended to meet current needs and sustainability requirements

Activities CCSF will evaluate existing building systems to ensure that the fundamental building elements and systems have specified functional and efficient performance. A 5-year improvement plan will be developed to repair/upgrade and/or repair components that do not meet specifications. Intended improvements will meet the requirements of current building usage, and address heating, cooling, humidity control lighting and safety systems, along with building automation control systems.

Materials & Resources

The requirements listed in this section of the Sustainability Plan were initially based upon the USGB LEED book of October 2005, and later reviewed with the November 2008 USGB LEED book. The CCSF stated requirements meet the minimum standards of the LEED book and in some cases, CCSF sets higher goals than outlined in the LEED book.

Building Reuse: Maintain 75% Existing Shell, OR Maintain 100% Shell Walls OR Maintain 100% of Interior & Non-Shell

Objective To extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport

Activities Existing and previously occupied buildings, including structure, envelope, and elements will be reused where possible on site as a first priority. Elements that pose contamination risk to building occupants will be removed and components that may improve energy and water efficiency such as windows, mechanical systems and plumbing fixtures will be upgraded.

Construction, Demolition and Renovation Waste Management: Divert/Recycle 50%-75% of Construction Waste

Objective To divert construction, demolition and land-clearing debris from disposal in landfills and incinerators, redirect recyclable recovered resources back to the manufacturing process and redirect reusable materials to appropriate sites at City College.

Activities CCSF will develop and implement a Waste Management Policy aimed at reducing overall waste generation and will employ deconstruction, salvaging and recycling techniques to reduce the quantity of debris generated. At a minimum, a goal of 50% or better will be established for diverting waste from landfills and incinerators and this will be part of the general requirements for any construction project. Each project team will develop and implement a construction waste management plan which will include the following: application of deconstruction techniques to reduce the quantity of waste generated on the site; recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation; designation of an area on the construction site for collection of recyclable materials; collection of data and calculation of the weight of recycled materials versus total weight of waste generated to track recycling efforts throughout the construction process; identification of construction haulers and recyclers to handle the designated materials; and reporting.

35% Reuse of Materials/Resources

Objective To reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources. Although LEED specifies a 5-10% reuse figure, CCSF will make every effort to reuse at least 35% of materials and products on every project.

Activities For major renovation projects, deconstruction techniques will be employed to salvage materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items. These salvaged materials may be reused in the project and/or other projects and/or sold to recycled material vendors.

Recycled Content: 25%- 50% and to optimize the use of Alternative Materials: 10% - 50%

Objective To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials, and to reduce the environmental impacts of the materials acquired for use in the operations, maintenance, and upgrade of buildings.

Activities Construction Projects

A recycled content material goal for each construction project will be set at 25% or better. The City of San Francisco's Green Building Materials Resource Guide, along with other resources, will assist the College to identify products/materials and suppliers that will assist in achieving this goal. Products/materials will be evaluated based on their environmental, economic and performance benefits and products/materials that offer the most benefit will be selected.

Activities An alternative materials goal for each construction project will be set at a minimum of 10%, seeking to achieve a target of 50%.

Regional Materials: 10-50% Manufactured, Extracted, Harvested, or Recovered Regionally

Objective To increase demand for building materials and products that are extracted, harvested, or manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation

Activities A goal of 10-50% will be established for materials manufactured regionally. Although LEED specifies a 10-20% regional goal for materials that are extracted, harvested, or recovered regionally, CCSF will have a goal of 10-50%. Project teams will research products/materials and suppliers that may be used to achieve this goal. Materials will be selected based on their environmental, economic and performance benefits. The project team will quantify and track the percentage of regionally manufactured, extracted, harvested or recovered products/materials that are installed, relative to all materials installed.

Rapidly Renewable Materials

Objective To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials

Activities Specify rapidly renewable materials for 5% or more of total building materials. The following materials will be considered where applicable: bamboo flooring, wool carpet, strawboard, cotton batting insulation, linoleum flooring, poplar oriented strandboard (OSB), sunflower seed board, and wheatgrass cabinetry. Rapidly renewable materials installed on the project during construction will be quantified and tracked by the project team.

Certified Wood

Objective To encourage environmentally responsible forest management

Activities All new construction projects and renovations will use 50% or better Forest Stewardship Council (FSC) certified wood products, including natural renewal wood substitutes such as bamboo.. Each project team will keep record of the total percentage of FSC-certified wood products installed on the project.

Source Reductions and Waste Management: Policy and Waste Stream Audit

Objective To establish minimum source reduction and recycling program elements and quantify current waste stream production volumes

Activities Waste Management Policy. The College has a policy aimed at reducing wastes generated on all campuses. Periodic waste stream audits will be conducted to establish the current building waste baseline. The identified waste types will be evaluated and techniques will be implemented to encourage source reduction, reuse and recycling. The waste management policy will include procurement/management procedures to reduce waste stream through source reduction purchasing strategies, reuse, recycling, composting, collection station equipment and agreements, and occupant education to ensure successful implementation.

Optimize Use of Indoor Air Quality (IAQ) Compliant Products: 45-90% of Annual Purchases

Objective To reduce the IAQ impacts of the materials acquired for use in the operation, maintenance and upgrades of buildings

Activities CCSF will specify the above listed sustainability criteria for all materials, supplies and/or equipment purchases.

Storage and Collection of Recyclables

Objective To facilitate the reduction of waste in new and existing buildings

Activities In new construction and existing buildings, CCSF will designate easily accessible and well-lighted areas for collection and storage of non-toxic recyclable materials (paper, cardboard, glass, plastics, metal, etc.) Designated areas at all buildings will be equipped with separate and appropriate collection bins for recyclable and non-recyclable wastes. Bins will be clearly labeled.

Reduced Mercury in Light Bulbs

Objective To establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into existing buildings through light bulbs

Activities CCSF will initially institute and follow a light bulb purchasing program that keeps the weighted average mercury content below 100 picograms of mercury per lumen hour. Subsequently, the College will work with the SFPUC to establish and implement a light bulb purchasing program that keeps the weighted average mercury content of all mercury-containing light bulbs below 80 picograms per lumen hour of light output.

Indoor Environmental Quality

Indoor Air Quality (IAQ) Performance

Objective To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants

Activities

Indoor Air Quality Management Program The College will develop an indoor air quality management program to address related and potential problems. For construction/renovation related activities, CCSF will work with all contractors and subcontractors to implement a construction Indoor Air Quality (IAQ) management plan in accordance with the requirements of the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) IAQ Guidelines. The Indoor Air Quality (IAQ) Management Plan will be implemented during the construction and pre-occupancy phases of the building as follows: during construction, minimum requirements of the SMACNA IAQ Guideline for Occupied Buildings under Construction will be met or exceeded. On-site stored or installed absorptive materials will be protected from moisture damage, and all filtration media will be replaced immediately prior to occupancy. As part of the project general requirements, all contractors and sub contractors will be required (at minimum) to adhere to following procedures:

- a. All ducts, equipment and absorptive materials will be protected during the construction process to prevent contamination. Air handlers will not be operated during construction. The contractors and subcontractors will be required to install suitable filters in the air handlers prior to start-up for testing and balancing and following the completion of all interior construction.
- b. The College may contract with an independent commissioning agent to provide feedback on the IAQ management practices being employed on project sites and all contractors and/or subcontractors will be required to correct problems identified. All testing and balancing will be conducted following the completion of interior construction.
- c. Pollution source control measures will include but not limited to the following:
 - i. Protection of all building materials against moisture exposure
 - ii. Monitoring the use of porous materials. Any porous materials that have been exposed to moisture must be dried before installation. Any porous material that remains wet longer than 48 hours, or shows signs of visible mold will be discarded and replaced. Implementation of appropriate measures to ensure that the construction process does not result in moisture intrusion.
 - iii. Use low-emitting products that comply with Volatile Organic Compound (VOC) requirements of the South Coast Air Quality Management District. All Material Safety Data Sheets (MSDS) must be approved by a College representative and stamped before they are used in the project.
 - iv. Measures to prevent transport of pollutants into work areas by limiting access to the interior of building during stud framing, drywall and installation of the mechanical equipment.
 - v. High-VOC materials must be allowed to off-gas prior to installation. New plastic, fabric, laminates, or assembled materials that are packaged or rolled-up will be opened up and ventilated for a minimum of four days outside of buildings. Subcontractors will be encouraged to off-gas materials in their shop and supply a Letter of Certification to a College representative prior to its arrival on site.
 - vi. HVAC equipment will be stored in a clean, dry location until they are fully installed.
 - vii. All applicable means and methods will be employed to minimize dust.
 - viii. The work will be sequenced to ensure that porous materials are installed after a new building is closed in and dried in, and carpeting will be furnished after the interior finishes have fully cured.

Ventilation systems will be designed to meet or exceed the minimum outdoor air ventilation rates as described in the ASHRAE standard. The impacts of ventilation rates on energy use and indoor air

quality will be balanced to optimize for energy efficiency and occupant health. The ASHRAE 62 Users Manual will be used for detailed guidance to meeting this requirement.

Carbon Dioxide (CO₂) Monitoring

Objective To provide capacity for indoor air quality (IAQ) monitoring to sustain long-term occupant health and comfort

Activities HVAC systems will be designed with carbon dioxide monitoring sensors where possible and sensors will be integrated with the building automation system (BAS).

Increase Ventilation Effectiveness

Objective To provide for the effective delivery and mixing of fresh air to support the health, safety, and comfort of building occupants

Activities HVAC systems and building envelopes will be designed to optimize air change effectiveness. Air change effectiveness will be optimized using a variety of ventilation strategies including displacement ventilation, low-velocity ventilation, plug flow ventilation such as underfloor or near-floor delivery, and operable windows. The air change effectiveness of all buildings will be tested after construction.

For Mechanically Ventilated Spaces, heat recovery will be used where possible to minimize the additional energy consumption associated with higher ventilation rates.

For Naturally Ventilated Spaces, the following eight design steps described in the Carbon Trust Good Practice Guide 237 – 1) will be adopted:

1. Develop design requirements;
2. Plan airflow paths;
3. Identify building uses and features that might require special attention;
4. Determine ventilation requirements;
5. Estimate external driving pressures;
6. Select types of ventilation devices;
7. Size ventilation devices;
8. Analyze the design.

Public domain software may be used to analyze room-by-room airflows includes NIST's CONTAM, Multizone Modeling Software, LoopDA, and Natural Ventilation Sizing Tool.

No- or Low- Emitting Materials

Objective To reduce the quantity of indoor air contaminants which are odorous or potentially harmful to the health and comfort of installers and occupants

Activities No- or Low-Volatile Organic Compound (VOC) materials will be required in the construction documents for all projects. VOC limits relating to adhesives, sealants, paints, coatings, carpet systems, and composite woods will be clearly stated in each corresponding section of the Technical Specification.

Indoor Chemical & Pollutant Source Control

Objective To avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality and/or reduce exposure of building occupants and maintenance personnel to potentially hazardous particle contaminants which adversely impact air quality, health, building finishes, building systems and the environment

Activities Separate exhaust and plumbing systems will be designed for rooms with contaminants to physically isolate them from the rest of the building. Permanent architectural entryway systems such as grills or grates will be installed to prevent occupant-borne contaminants from entering buildings.

Non-Cleaning System – Reduce Particulates in Air Distribution: In-place filters with particle removal effectiveness MERV 13 or greater will be installed and maintained for all outside air intakes and returns for the re-circulation of inside air. Maintenance and replacement schedules will be established for these filters.

Non-Cleaning – Isolation of High-Volume Copying/Print Rooms/Fax Stations: CCSF will install structural deck-to-deck partitions with separate outside exhausting, no air re-circulation and negative pressure to contain and isolate high-volume copying/print rooms/fax stations. A plan will be developed to minimize unnecessary use of convenience printers and copiers by moving larger copying and printing jobs currently being done on convenience copiers and printers to high- volume printers and copiers in isolated spaces.

Controllability of Systems

Objective To provide a high level of temperature, ventilation and lighting control by individual occupants or specific groups in multi-occupant spaces (e.g., classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants

Activities Buildings will be designed with occupant controls for airflow, temperature, and lighting. Additional strategies to be considered will include but are not limited to task lighting, operable windows and underfloor HVAC systems with individual diffusers.

Thermal Comfort

Objective To provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants

Activities CCSF will comply with the ASHRAE Standard 55-2004 for thermal comfort standards including humidity control within established ranges per climate zone as funding may allow. Building envelopes and HVAC systems will be designed to maintain comfort ranges based on established temperature and humidity comfort ranges. Humidity monitoring systems will be installed and maintained in buildings to automatically adjust building conditions as appropriate.

Daylight & Views

Objective To provide a connection between indoor spaces and outdoor environments through the introduction of sunlight and views into the occupied areas of the building

Activities Buildings and/or facilities will be designed to maximize daylight and viewing opportunities. Techniques will include but are not limited to building orientation, shallow floor plates, increased building perimeter, exterior and interior shading devices, high performance glazing, and photo-integrated light sensors. Model daylighting strategies with a physical or computer model may be used to assess footcandle levels and daylight factors achieved.

Contemporary IAQ Practice

Objective To enhance IAQ performance by optimizing practices to prevent the development of indoor air quality problems in buildings, correcting indoor air quality problems when they occur and, maintaining the well-being of the occupants

Activities CCSF will institute a program to enhance IAQ performance by optimizing practices to prevent the development of indoor air quality problems in all buildings in order to maintain and/or improve the well-being of all occupants. Building systems will be periodically evaluated in order to identify and repair IEQ problems. The program will include ongoing problem prevention measures which will include prevention of moisture accumulation and mold in buildings and procedures to maintain a high level of IAQ on an ongoing basis. For additional information, the EPA Web site, www.epa.gov/iaq/largebldgs/baqtoc.html , will be consulted.

Green Cleaning

Objective To reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological and particle contaminants which adversely impact air quality, building finishes, building systems and the environment.

Activities

Entryway Systems: All exterior entrances with entryway systems (grills, grates, mats etc.) will be designed to catch and hold dirt particles and to prevent contamination of the building interior. Exterior stone, brick or concrete surfaces will drain away water from building entrances, as will low-maintenance vegetation

incorporated in the landscape design for building entrances. Plants, trees and bushes that yield berries, flowers and leaves that are likely to be tracked into the building should be avoided at building entrances. The plant selection will be based on the appropriate Integrated Pest Management approach to eliminate pesticide applications with diffusion into buildings. Where possible, water spigots and electrical outlets will be provided at entryways for maintenance and cleaning activities.

Isolation of Janitorial Closets: Structural deck-to-deck partitions or related material will be used to separate outside exhausting, no air re-circulation and negative pressure in all janitorial closets. Hot and cold water and drains plumbed for appropriate disposal of liquid waste will be provided in janitorial equipment storage areas and locations for mixing water and cleaning chemical concentrate. CCSF will implement policies, procedures and mixing systems that minimize exposure of cleaning staff to concentrated cleaning chemicals.

Existing Buildings Only: Outside Air Introduction and Exhaust Systems

Objective To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the health and well-being of the occupants

Activities Visual inspection of Outside Air (OA) vent/dampers will be conducted and any OA air vent/louver obstructions that restrict full OA capacity from entering the distribution system will be removed. The airflow will be monitored, recorded in CFM and compared to design flow for each unit. Operation of each exhaust fan will be tested to ensure that the exhaust airflow meets design requirements/intentions. CCSF will adopt the U.S. EPA Guidelines for HVAC System Maintenance which provides guidance on developing, implementing and maintaining an HVAC System Maintenance Program to ensure the proper operations and maintenance of HVAC components.

Asbestos, Lead and other Hazardous Material Removal or Encapsulation

Objective To reduce the potential exposure of building occupants to asbestos, lead and other hazardous materials and prevent associated harmful effects in existing buildings

Activities CCSF will solicit the services of a hazardous material consultant to develop and implement a hazardous material management program. The program will identify the applicable regulatory requirements and procedures for the removal, handling and disposal of hazardous materials in buildings. Hazardous material related work done on prior projects will be reviewed and the data will be used to prepare a history-based component of the hazardous material survey and will include but are not limited to: (1) location of removed materials, (2) locations expected to have hazardous materials, and (3) removal procedures. This survey will be updated periodically with other information such as: (1) sampling of expected locations, (2) results from test samples, and (3) new locations.

Polychlorinated Biphenyl (PCB) Removal

Objective To reduce the potential exposure of building occupants to PCBs and PCB combustion by-products in case of fire in the building

Activities CCSF will develop and implement a PCB management program which will identify the applicable regulatory requirements and procedures for addressing PCBs on an ongoing basis.

Outdoor Air Delivery Monitoring

Objective To provide capacity for a ventilation system monitoring program to help sustain long-term occupant comfort and well-being

Activities CCSF will install and/or maintain permanent monitoring systems that provide feedback on ventilation system performance to ensure that the systems maintain minimum ventilation rates

Chapter 3 Sustainable Operations

Overview

CCSF will avoid depletion of natural resources and environmental degradation in its operations. It will maintain environments that are healthful and conducive of learning and working. Included in this effort will be a continual updating of science knowledge to best balance the habitability concerns of our college community with our desire to reduce our negative environmental impact on our surroundings. The College has put a number of policies in effect to promote sustainability in operations. Some of the plans that follow predate the creation of this document and are well underway; in other cases implementation has only begun or will be effectuated in accordance with implementation timelines to be developed in 2008-2009. **Note that many effective sustainable operations strategies will depend on staff development. In-service training and all professional development and awareness efforts will be covered in the CCSF Sustainability Plan Part 2.**

Policies

The College will continue to develop and to implement policies, programs and practices to enhance its commitment to environmental sustainability. The following policies have been adopted to govern the planning, design and construction of physical facilities, to ensure efficient use of resources, and to minimize waste generation:

- Provision and operations of physical facilities
- Development and implementation of the Master Plan
- Ban on sales of tobacco products on all College campuses
- CCSF Injury and Illness Prevention Program for Workplace Security (IIP) Plan
- CCSF Emergency Plan
- Environmental Quality procedures for administering the College's responsibilities under California Environmental Quality Act (CEQA)
- Conservation of Energy Resources Policy

Environmental policies and activities to govern areas of Solid Waste Management, Hazardous Materials, Conservation and Air Quality, Transportation, Purchasing, Grounds-keeping, Facilities, and Curriculum, Education and Staff Development (Policy Manual 7.22, Facilities)

Transportation Demand Management (TDM)

Objective To reduce air pollution on all campuses and to decrease the percent of automobile trips, by promoting transit use, carpooling, bicycling and motorcycling, to all campuses; pursue a goal of 15-20% reduction over the next five to ten years.

Activities

Transit One Program for Faculty and Staff: Continue to offer (through AFLAC) Transit One, a pre-tax transportation program allowing employees to put aside up to \$100 each month pre-tax from their paycheck for their public transit costs. Explore extension of this benefit to student workers. Investigate the feasibility of partial subsidization of the cost of Muni and BART passes for students and employees.

Campus Police Escort Program: Continue the Police Escort Program, whereby individual students, staff, and faculty are escorted by foot to bus stops and parking lots on campus or immediately adjacent (excluding BART). Provide escorts when available. Pursue the possibility of hiring a designated campus control officer to take primary responsibility for providing Police Escort Services.

Ride Share Program: Encourage ridesharing by posting <http://www.ridenow.org/carpool> and 511.org on CCSF main website. Explore the idea of an internal database to further promote ridesharing within our community.

Parking Fees: Study parking arrangements/fees as these relate to students and employees. Discuss with College community and students how parking fees directly promote the use of environmentally friendly alternative transportation. Raise the issue of employee parking fees in collective bargaining. Continue and increase financial incentives for staff and faculty who do not drive to work (such as free transit passes or discounts on dining).

MUNI/BART Class Pass for Students: Continue discussions with MTA to establish a class pass program for students. A Class Pass sticker attached to the students' ID card would allow them free MUNI access.

Bicycle Accommodations: Establish a streamlined and well publicized process to honor student/ staff requests for bicycle rack installations. Continue partnerships with the SF Bicycle Coalition to develop and update bike routes between key feeder neighborhoods and nearby campuses and between campuses.

- The CCSF goal will be for new construction projects and renovation projects to include transportation amenities such as bicycle racks and showering/changing facilities in or near all buildings.
- Create and identify bike routes with signage (such as the "sharrows" identifying city bike routes) on campuses. Include and prioritize bike and pedestrian routes in new construction.
- Include bicycle rack and bicycle service locations in all new maps for City College. Make these maps and public transit maps and information available at campus bookstores.
- Introduce and encourage innovative programs such as bicycle-sharing programs, indoor bike parking (e.g., the SFSU "Bike Barn") or expandable spaces for bicycle parking, bike kitchens (spare parts, bike repairs, etc.), bike swaps, and used bike sales. The student club, CCSF Green Corps, established a bike kitchen on the Phelan Campus in Fall 2008.

Replacement of Existing Vehicle Fleet: Study, develop and implement a 5-year plan to replace existing vehicle fleet with low or no emission high mileage vehicles with consideration for alternative fuels and electric vehicles.

Site Improvements to Support Transit Access: Collaborate with San Francisco Municipal Transportation Agency (MTA) to improve access to public transit system. Such improvements may include the construction of sidewalks, installation of pedestrian crosswalk signals, provision of sufficient spaces for required number of bus stops, pedestrian safety, ease of bicycle and pedestrian access to College facilities especially from mass transit stops. Install signage at strategic locations to promote the safety of drivers, bicyclists and pedestrians on bicycle routes.

Pedestrian and Bicycle Safety Program: The College's Police Department will continue to work to provide a safe environment for all faculty, staff and students. Continue the pedestrian safety program, aimed at reducing the number of pedestrian related accidents on all campuses, and expand the program to include bicycle safety. Through the CCSF Police Department, promote and provide resources on pedestrian and bicycle safety and security on all campuses, enforce traffic laws, provide safety tips for bicycle riders and other road users.

Campus Locations: Continue the strategy of locating campuses in the hearts of local communities, reducing automobile trips to these campuses.

Car Share Program: Use the City Care Share program to provide short-term and emergency vehicle access at key campus locations for faculty, staff and students including facilities' staff. Utilize only low-emitting and fuel-efficient vehicles.

Surrounding Neighborhood: Work with CCSF neighbors to identify and manage potential changes to residential parking and to effectively discourage students, faculty, and staff from parking in surrounding neighborhoods.

Shuttle Services Continue to research the use of shuttle services to support public transportation. The shuttle, if considered feasible, will service off-campus sites, including the Balboa Park BART Station and other College campuses. The College will also evaluate the possibility of joining other universities and colleges to establish a shuttle service which employs low emissions/alternative power vehicles and includes carseats and booster seats.

Additional Services: Continue to evaluate the feasibility of providing additional services such as restaurants, banking, etc., on all campuses, and a mid-week farmers' market at various campuses.

Reduction or Elimination of the Sale of Bottled Water

Air Quality

Indoor Air Quality (IAQ) [See Chap. 2]

Green Cleaning and Indoor Pest Management

Low Environmental Impact Cleaning Equipment Policy

The College will develop, implement, and maintain a policy for the use of janitorial equipment that maximizes effective reduction of building contaminants with minimum environmental impact. The College will work with the janitorial staff to evaluate current janitorial equipment and practices and a plan of action will be developed and implemented to upgrade and/or replace this equipment. [See also Purchasing section.]

Low Environmental Impact Pest Management Policy

The College will review current indoor pest management procedures and will develop a plan to upgrade these procedures. A College policy will be instituted and implemented to maintain a low environmental impact integrated indoor pest management program. Any cleaning products included in the integrated pest management program will meet the requirements described in Material and Resources Section.

Water Conservation Program

Objective _To reduce the overall water consumption and to ensure that water usage does not exceed 200,000 gallons per day

Activities Use the Energy Policy Act of 1992 fixture performance requirements to calculate the baseline water use. The baseline will take into consideration the expected increase in enrollment and facilities expansion over the next several years. Implement the following measures to achieve the water use goals:

All replacement water systems must be high efficiency and low-flow. High efficiency fixtures and dry fixtures such as waterless urinals, low flow shower heads, low-flow toilets, low flow sinks, water efficient dishwashers, cooling towers, and washing machines, water efficient faucets, etc. will be specified and installed in all new construction and renovation projects and retrofits.

High efficiency irrigation design and technology, drought tolerant plants and shrubs will be specified to limit the use of potable water for irrigation.

Separate meters will be installed at various locations on the campuses and/or buildings to monitor water consumption and the generation of waste water.

Annual audits of portable water use and wastewater volumes will be done at each campus.

Responses to leakages will be improved to reduce water loss and to prevent pollutants from entering the water supply system.

Water conservation measures will be incorporated in all new buildings and modernization projects, existing buildings and retrofits; this should include the phasing in of replacement drinking faucets that allow refilling of reusable water bottles.

A new maintenance program will address and improve leakage reporting and response.

The conservation program will be evaluated annually and improvements instituted.

The College will consider installing rainwater catchment systems and explore the feasibility of piloting (and later installing) greywater systems for existing buildings Districtwide.

The College will explore alternatives to the use of bottled water throughout the district, as well as directed by the Board of Trustees Resolution No: 090823-S3, such as improving the quality of the tap water on all campuses.

Landscaping

Objective To implement landscape planning, design, construction and practices that conserve water, reduce waste generation, minimize air, water, and soil pollution, require minimal maintenance and provide pleasant visual effects on all campuses

Activities

Landscape Planning and Design Guidelines: Develop a Landscape Master Plan and Design Guidelines as a framework for landscaping initiatives. These initiatives will be used to preserve, improve and reinforce the overall integrity of open spaces based on their historical significance, preservation of natural resources and usage intensity. Emphasis will be placed on the interaction among the campus community and physical barriers will be eliminated where possible. Pedestrian and wheelchair access to buildings and public spaces will be improved, and pedestrian, bicycle and vehicular circulation on campuses will be improved to reduce conflicts. Landscaping should be designed to encourage pollinators and attract birds and other species as well as to provide wildlife corridors.

The College and seek the help of habitat restoration experts (for example, faculty experts). Landscape design and plant selection will feature and prefer the use of native plants. Plants selected must contribute positively to habitat and wildlife corridors, and add to the attractiveness and enjoyment of the campus. Drought and wind tolerance, purchase cost, usefulness and safety, maintenance requirements, suitability for specific location, and compatibility with other plants will also be acknowledged as significant considerations in plant selection and landscape design. Lawns that are not regularly used by students to sit on are to be replaced with low-water-use native ground covers.

The College community will have advisory input into landscaping decisions on any campus. Departments which could be affected will be contacted before plants are removed or destroyed.

Landscape design and water use will conform to the water efficient landscape ordinance outlined by the California Department of Water Resources Model Ordinance. Perform soil/climate analysis to reduce or eliminate the need for irrigation by determining appropriate landscape types and design for each landscaping project.

Efficient Irrigation System: Specify high efficiency irrigation design and technology for all new construction and renovation projects. Institute a phased-in plan to replace inefficient irrigation systems with high efficiency systems. Install a greywater irrigation system to reduce potable water usage. Replace inefficient sprinklers with low-water-use drip irrigation systems in all areas except lawns. Cover exposed areas between plants in woodchips or landscape fabric to reduce water use and weeds. Assess the feasibility of using cisterns with collection of roof-top rain and dew.

Minimum use of pesticides and fertilizers: Utilize organic gardening practices including companion planting in lieu of pesticides and synthetic fertilizers.

Tree Care: Follow the same general guidelines for selection of trees as in selection of other plants (see Plant Selection). Solicit, as needed, the services of a State certified arborist to evaluate mature trees for any problems that may threaten the life of the tree. Design a care program to promote tree health and ensure their value will continue to grow. Where trees may be affected by a construction project, consult an arborist in the planning. The arborist may be required to work with the project teams throughout each construction project. Construction teams will adopt appropriate methods to reduce adverse impacts on mature trees. The College community will have advisory input into major decisions affecting trees on any campus.

Fences, Walls and Gateways: Use architectural tools such as gateways to provide identity, scale and create a sense of community for the campuses. Provide gateways with adequate lighting, circulation, planting and signage. The height of any fences should enhance the view.

Paving: For all applicable projects, specify light-colored porous paving material along the sidewalks, parking areas, plazas and other hard surfaces to reduce storm water runoff. Specify paving material with up to 100% recycled content. The selection of recycled materials should be done with attention to the existing soil and underlying rock structure at each site.

Site Lighting: Adhere to the vehicular/pedestrian lighting requirement of the City of San Francisco. Improve existing light quality without increasing offsite light impact to adjacent properties. Utilize pedestrian level bollards and/or pole lights; make lamping consistent with adjacent buildings and/or properties. For new construction, continue to phase in solar-powered, LED, and sensor-driven lighting fixtures. Pursue a long-term goal of replacing all fixtures in this way. Utilize fixtures that cast light downward, not upward.

Site Furnishing: Select Site furnishing (e.g., benches, tables, litter/ash receptacles, planters, bike racks, and bollards) for functional and aesthetic purposes. Seek first to reuse existing furnishings, purchasing new ones with 100% recycled content as a second option. For furnishings that must come from wood, the College should only purchase FSC-Certified (Forest Stewardship Council) wood. Develop a plan to replace and or repair old site furnishings.

Landscape Maintenance: Establish a maintenance program including regular inspections, mulching, fertilizing, pruning, and problem detection, to provide necessary landscape care.

Innovative Wastewater Technologies

Objective To reduce potable water demand and wastewater generation

Activities The College's water conservation program will target appropriate measures to reduce potable water use for building sewage conveyance by 50% through the use of technologies such as waterless urinals, and other water efficient fixtures.

Discharge Water Compliance for Existing Buildings Only

Objective To protect natural habitat, waterways and water supply from pollutants carried by building discharge water.

Activities Each project team will follow the National Pollutant Discharge Elimination System (NPDES) requirements where applicable, and the team will also use technical information on the EPA requirements as reference for compliance. Where an NPDES Permit has been obtained, the team will establish a Discharge Monitoring Report (DMR) process to keep the permit in compliance.

Conservation of Resources and Materials

Objectives To reduce solid waste generated, meeting or exceeding State requirements to recycle 75% of solid waste generated and to purchase products/materials with 40% recycled content.

Activities

College Recycling Program: Increase recycling revenue and implement the Municipal Health Code Sec. 293.1 throughout the District. This code discourages removal of any recycling materials from any CCSF recycling containers or collection site. i.e. *CRV- California Redemption Value (beverage containers)*.

Continue, and as feasible, expand current recycling efforts now in place throughout the District, with the addition of designated collection sites at all campuses. This expansion will include all potential recyclable materials.

Expand the college "Reuse Program," which utilizes and exchanges all surplus and reusable District furniture and other materials.

Manage all electronic waste and universal waste throughout the District to ensure that all toxic and electronic wastes generated from the College's operation and activities are safely collected, recycled and disposed of properly.

Maintain the Electronic Recycler's Pledge of True Stewardship created by the Basel Action Network (BAN). The pledge holds participating e-recyclers to a set of high standards including a ban on export, land dumping, incineration, and use of prison labor for toxic components and verify that toxic fractions of e-waste end up in responsible destinations.

Take measures to encourage reduction of plastic beverage containers on CCSF campuses and encourage additional reuse (e.g., sell steel or otherwise reusable water bottles at College bookstores).

Composting Program: As part of the College goal to reduce solid waste by 75%; develop compost infrastructure throughout the campuses. Require all vendors to comply with San Francisco's recent ordinances that ban any non-reusable, non-compostable or non-recyclable "to go" containers.

Develop additional on-site composting programs in conjunction with the Environmental Horticulture and Culinary Arts and Hospitality Studies Departments at all campuses where these programs are offered.

Sustainable Purchasing and Procurement

Purchases and other Procured Products/Materials

The College's Purchasing Department will abide by the October 2005 California State Senate's law on recycled product requirements and /or the above stated sustainability criteria. The overall minimum goal for products/material will be 25% or better. Included in this legislation: paper products, writing and printing papers, janitorial papers, file folders, copy paper, offset, forms, computer printout paper, envelopes, newsprint, manila envelopes, note pads, post its, posters, calendars, magazines, etc.; toner for copiers and printers, paint, antifreeze, lubricants; glass products: windows, test tubes, beakers, lab supplies, deburring media, fiberglass, etc.; plastic products: including, but not limited to wastebaskets, buckets, mats, signs, binders, trays, plastic lumber, carpet; metal products: including, but not limited to staplers, paper clips, scissors, chairs, desks, file cabinets, shelving, lockers, nails, screws and construction materials.

Toxic Material Source Reduction: Reduced Mercury in Light Bulbs

Objective To establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into buildings through purchases of light bulbs

Activities CCSF will initially institute and follow a light bulb purchasing program that keeps the weighted average mercury content below 100 picograms of mercury per lumen hour. Subsequently, the College will work with the SFPUC to establish and implement a light bulb purchasing program that keeps the weighted average mercury content of all mercury-containing light bulbs below 80 picograms per lumen hour of light output.

Sustainable Cleaning Products and Materials

Objective To reduce the environmental impacts of cleaning products, disposable janitorial products, and floor coating products

Activities Include sustainable cleaning materials and disposable janitorial products, when these are the most sustainable option. Institute a low-impact environmental cleaning products and housekeeping policy that will address sustainable cleaning and hard flooring coating systems products and utilization of concentrated cleaning products. Floor coating products will be free of zinc.

Internal/External organization materials & equipment reuse program

Institute a materials and equipment reuse program, to include, but not to be limited to the following:

Building Materials – Lumber, tools, windows, doors, light fixtures, paint, plumbing supplies and fixtures, architectural pieces, fencing, hardware, and materials left over from other projects.

Office Furniture and Supplies – Desks, tables, chairs, filing cabinets, credenzas, shelving units, stacking trays, tape dispensers, notebook binders, folders and other equipment and office supplies

Computers and Electronics – Personal computers, printers, fax machines, televisions, video cassette recorders, videocassettes, etc

Art Materials – Fabric, painting, lumber, stage props, paints, brushes, etc.

Others – Boxes, bags, stoves, refrigerators and freezers (that do not contain CFCs, HCFCs or halons), etc

Reduction in Paper Usage

All paper procured by the District will contain at least 35% recycled material. Departments, employees, and students will be required to use double-sided printing and photocopying. The District will adopt a policy requiring setting “default” margins on all District printers to no wider than 1”.

Food Purchasing

The College will pursue a sustainable food purchasing policy to encourage sustainable farming and socially sustainable labor practices. Affordability and competitive pricing will continue to be an important criterion, as will the provision of vegetarian and vegan options.

- When prices are comparable within 20% of the least expensive acceptable mass market alternative, preference will be given to high quality food grown, processed and transported under any of the following conditions: fair trade or unionized working conditions; sustainable farming practices or certified organic; locally or U.S. West Coast grown; meats, poultry, dairy and eggs with no antibiotics and/or free range or cage free as applicable.
- The College will encourage the development of a farm-to-college program to increase the use of local/organic produce.
- CCSF will explore purchasing partnerships and best practices of other local colleges in order to overcome logistical barriers to implementation of this policy.
- This policy will apply to contracted vendors at any CCSF campus as well as the cafeteria and any other CCSF food service.

Energy Conservation Program

Objective To maximize energy performance in buildings and to exceed Title 24 - 2001 California energy efficiency standards

Activities Identify, review and implement energy savings initiatives including but not limited to the following: Perform periodic energy audits to identify economically viable improvements that will contribute substantially to energy savings.

Set all thermostats at the most efficient comfort levels; no higher than 68 degrees at night during the winter months. Audit thermostat function.

Discontinue the use of air conditioning and electric heaters, except in areas where there is sensitive equipment, or where environmentally-friendly alternatives are found infeasible to ensure comfortable conditions for employees and students. Keep doors closed in any air-conditioned or heated areas.

Develop and implement a plan to phase in renewable energy sources on existing rooftops (e.g., wind turbines and/or solar photovoltaic and solar thermal panels).

Purchase and use Energy Star rated equipment such as computers, printers, fax machines and scanners. Replace existing CRT monitors with flat-screen LCD monitors as funding may allow.

Use departmental coffee makers and refrigerators instead of personal units.

Replace light bulbs with more efficient compact fluorescent and LED bulb lighting.

Operations and Maintenance Program

Objective To implement cost-effective procedures and practices to ensure that all College facilities and building systems are reliable, safe, and energy efficient.

Activities

Operations and Maintenance Manual: Develop and deploy an Operations and Maintenance Manual to guide Operations and Maintenance management and technical staff. See Sustainability Plan Part 2 regarding staff development uses of the manual.

Building Systems Maintenance and Monitoring Programs: The guide will include a comprehensive Best Practices Equipment Preventative Maintenance Program to manage in-house maintenance services and/or contractual services for post-warranty maintenance. Use automated systems to monitor equipment functions and indoor conditions where possible, and provide training on all new systems.

Alternative Transportation

Objective To reduce pollution and land development impacts from automobile use

Activities The College has outlined a Transportation Demand Management (TDM) Program to reduce air pollution on all campuses. The College's strategy will include measures to decrease the percentage of automobile trips to all campuses by 5-10% each year. Elements of the program are described below:

Public Transportation Access: All campuses are well served by the San Francisco and Bay Area mass transit network, and the College will continue to site buildings and/or facilities within ½ mile of existing, planned and funded commuter rail or light rail or within ¼ mile of one or more stops for two or more public bus lines. Routine transportation surveys will be carried out to identify and to respond to transportation needs of existing and future building occupants.

Bicycle Rack, Storage and /or Changing Rooms: The CCSF goal is for new construction projects and renovation projects to include bicycle racks and showering/changing facilities in or near all buildings.

Parking Capacity and Demand Control Measures: The College's parking supply will not exceed the minimum local zoning requirements and will not be expanded beyond existing levels without the implementation of all feasible TDM measures. Demand will be evaluated continuously to monitor and to minimize traffic on all campuses. CCSF will continue to work with Municipal Transportation Agency (MTA) to improve pedestrian and bicycle access to all campuses.

Operations and Maintenance

Objective To support appropriate operations and maintenance of buildings and building systems so that they continue to deliver target building performance goals over the long term

Activities

Building Systems Maintenance: CCSF will develop a comprehensive Best Practices Equipment Preventative Maintenance Program to provide in-house maintenance services and/or contractual services to deliver post-warranty maintenance.

Building Systems Monitoring: Automated systems will be used to monitor equipment function and indoor space conditions where possible. This will help in early detection of system problems and quick response to such problems.

Performance Measurement: Emission Reduction Reporting

Objective To document emission reduction benefits of building efficiency actions, retire a portion of the reductions and reduce emissions in the supply chain

Activities CCSF will identify and address significant pollutants delivered by building energy systems. These include all pollutants identified to have negative health problems along with other environmental and economic impacts such as carbon dioxide (CO₂), sulfur dioxide (SO₂), nitrogen oxides (NO_x), mercury (Hg), small particulates (PM_{2.5}), large particulates (PM₁₀) and volatile organic compounds (VOCs).

Appendix 2: Implementation Table

Sustainability Requirements for all Construction Projects (Chapter 2)	Objectives (Activities are described in detail in body of plan; all projections are based on funds available)	Status as of December 2009
Conceptual Design to Post Construction	To attain LEED Silver Rating	Joint Use Facility (expect Gold in Fall 2010); Chinatown (expect Gold in 2012)
Mitigation Monitoring and Auditing Program for Master Plan Projects	To reduce the environmental impact resulting from the construction of the Master Plan projects	Check with Peter Goldstein on EIR
Reduced Site Disturbance	To conserve existing natural areas, restore damaged areas, provide habitat and promote biodiversity	Completed; annual report on work with Environmental Horticulture/Floristry dept & Buildings and Grounds dept.
Landscape and Exterior Design to Reduce Heat Islands	To reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat	Revisit in 2011 as funds become available
Light Pollution Reduction	To eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments	For new buildings in progress, for older buildings as funds are available
Plan for Green Site and Building Exterior Management	To encourage grounds/site/building exterior management practices that have the lowest environmental impact possible, and to preserve ecological integrity, enhance diversity and to protect wildlife while supporting building performance and integration into surrounding landscapes	Ongoing; continue to work with Environmental Horticulture/Floristry dept to implement
High Development Density Buildings and Areas	Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources	In progress for new buildings, for older buildings as funds are available

Existing Buildings only	To provide a distinction between buildings considered for new construction certification and buildings that are eligible to apply existing building certification. The CCSF goal for the operating performance and upgrades of all buildings two years and older will be to seek to attain LEED-Existing Building Silver Rating or higher, 43+ points	Survey in 2011 if funds become available
Water Conservation	Governor Schwarzenegger has put forth a goal of 20 percent reduction in water use by 2020. City College will meet or exceed this 20 percent reduction goal through the use of the construction standards	Completed for new buildings; for remodels ongoing; can provide reports for last 3 yrs by month
Water Efficient Landscaping	To minimize or eliminate the use of potable water for landscape irrigation	Completed; ongoing report annually
Stormwater Management Infrastructure	To reduce negative impact on water and air quality by increasing on-site infiltration, minimizing storm-water runoff, and reducing contaminants during and after construction	Partially completed; ongoing for construction projects; report annually
Minimum Energy Performance	To establish the minimum level of energy efficiency for proposed building and related systems	Completed for Joint Use, Chinatown, Performing Arts
CFC Reduction in HVAC&R Equipment	To reduce ozone depletion	Partially completed; ongoing for any new purchases; report annually
Optimize Energy Performance	To achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use	Partially completed; continue to work with PGE to monitor and reduce usage
Renewable Energy	To encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use	Completed for Joint Use, Chinatown; for existing buildings survey as funds available

Additional Commissioning	To verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended	Completed for Joint Use, Chinatown, and all new construction projects
Ozone Depletion and Additional Ozone Protection	To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to global warming	Completed for Joint Use, Chinatown
Performance Measurement, Verification and Enhanced Metering	To provide for the ongoing accountability and optimization of building energy and water consumption performance over time, and add incentives for additional energy reduction	Completed for Joint Use, Chinatown; for existing buildings survey and implement recommendations as funds available
Sustainable Building Cost Impacts Documentation	To document sustainable building cost impacts and select a lifecycle cost model for determining the lifecycle cost of any new facilities.	Effective immediately; lifecycle cost model to be used as part of the analysis for any projects placed on future college bond measures – the date of the next bond measure has not been determined yet
Existing Building Commissioning	To verify that fundamental building systems and assemblies are performing as intended to meet current needs and sustainability requirements	2012 for verification and 2017 to implement identified improvements
Building Reuse: Maintain 75% Existing Shell, OR Maintain 100% Shell Walls OR Maintain 100% of Interior & Non-Shell	To extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport	Ongoing work
Construction, Demolition and Renovation Waste Management: Divert/Recycle 50%-75% of Construction Waste	To divert construction, demolition and land-clearing debris from disposal in landfills and incinerators, redirect recyclable recovered resources back to the manufacturing process and redirect reusable materials to appropriate sites at City College.	Ongoing work

35% Reuse of Materials/Resources	To reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources. Although LEED specifies a 5-10% reuse figure, CCSF will make every effort to reuse at least 35% of materials and products on every project.	Ongoing work
Recycled Content: 25%- 50% and to optimize the use of Alternative Materials: 10% - 50%	To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials, and to reduce the environmental impacts of the materials acquired for use in the operations, maintenance, and upgrade of buildings.	Completed for Joint Use and Chinatown; ongoing work
Regional Materials: 10-50% Manufactured, Extracted, Harvested, or Recovered Regionally	To increase demand for building materials and products that are extracted, harvested, or manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation	Completed for Joint Use and Chinatown; ongoing work
Rapidly Renewable Materials	To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials	Completed for Joint Use and Chinatown; ongoing work
Certified Wood	To encourage environmentally responsible forest management	Completed for Joint Use and Chinatown; ongoing work
Source Reductions and Waste Management: Policy and Waste Stream Audit	To establish minimum source reduction and recycling program elements and quantify current waste stream production volumes	Implemented through wide District and Solid Waste Management Program; provide annual progress reports
Optimize Use of Indoor Air Quality (IAQ) Compliant Products: 45-90% of Annual Purchases	To reduce the IAQ impacts of the materials acquired for use in the operation, maintenance and upgrades of buildings	Partially completed; ongoing work as funds available
Storage and Collection of Recyclables	To facilitate the reduction of waste in new and existing buildings	Implemented through District and Solid Waste Management Program; provide annual progress reports

Reduced Mercury in Light Bulbs	To establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into existing buildings through light bulbs	Mercury light bulbs no longer purchased; replace existing bulbs as funds become available
Indoor Air Quality (IAQ) Performance	To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants	In 2012 conduct assessment and implement recommendations as funds available
Carbon Dioxide (CO ₂) Monitoring	To provide capacity for indoor air quality (IAQ) monitoring to sustain long-term occupant health and comfort	In 2012 conduct assessment and implement recommendations as funds available
Increase Ventilation Effectiveness	To provide for the effective delivery and mixing of fresh air to support the health, safety, and comfort of building occupants	In 2012 conduct assessment and implement recommendations as funds available
No- or Low- Emitting Materials	To reduce the quantity of indoor air contaminants which are odorous or potentially harmful to the health and comfort of installers and occupants	Completed for Joint Use, Chinatown; annual reports from Building and Grounds Dept. and Purchasing Dept.
Indoor Chemical & Pollutant Source Control	To avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality and/or reduce exposure of building occupants and maintenance personnel to potentially hazardous particle contaminants which adversely impact air quality, health, building finishes, building systems and the environment	In 2012 conduct assessment and implement recommendations as funds available
Controllability of Systems	To provide a high level of temperature, ventilation and lighting control by individual occupants or specific groups in multi-occupant spaces (e.g., classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants	In 2012 conduct assessment and implement recommendations as funds available

Thermal Comfort	To provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants	In 2012 conduct assessment and implement recommendations as funds available
Daylight & Views	To provide a connection between indoor spaces and outdoor environments through the introduction of sunlight and views into the occupied areas of the building	Completed for Chinatown, Joint Use, Performing Arts buildings
Contemporary IAQ Practice	To enhance IAQ performance by optimizing practices to prevent the development of indoor air quality problems in buildings, correcting indoor air quality problems when they occur and, maintaining the well-being of the occupants	In 2012 conduct assessment and implement recommendations as funds available
Green Cleaning	To reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological and particle contaminants which adversely impact air quality, building finishes, building systems and the environment	Partially completed; ongoing work as funds available
Existing Buildings Only: Outside Air Introduction and Exhaust Systems	To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the health and well-being of the occupants	In 2012 conduct assessment and implement recommendations as funds available
Asbestos, Lead and other Hazardous Material Removal or Encapsulation	To reduce the potential exposure of building occupants to asbestos, lead and other hazardous materials and prevent associated harmful effects in existing buildings	Ongoing; provide annual progress reports
Polychlorinated Biphenyl (PCB) Removal	To reduce the potential exposure of building occupants to PCBs and PCB combustion by-products in case of fire in the building	Ongoing; provide annual progress reports
Outdoor Air Delivery Monitoring	To provide capacity for a ventilation system monitoring program to help sustain long-term occupant comfort and well-being	In 2012 conduct assessment and implement recommendations as funds available

Sustainable Operations (Chapter 3)	Objectives (Activities are described in detail in body of plan)	Timeline
Transportation Demand Management	To reduce air pollution on all campuses and to decrease the percent of automobile trips, by promoting transit use, carpooling, bicycling and motorcycling, to all campuses; pursue a goal of 15-20% reduction over the next five to ten years.	5 – 10 years; monitor report yearly as funds available for EIR Report recommendation
Water Conservation	To reduce the overall water consumption and to ensure that water usage does not exceed 200,000 gallons per day	Completed for Joint Use and Chinatown; effective immediately for all new buildings; retrofit as funds become available
Landscaping	To implement landscape planning, design, construction and practices that conserve water, reduce waste generation, minimize air, water, and soil pollution, require minimal maintenance and provide pleasant visual effects on all campuses	Completed for Joint Use and Chinatown; effective immediately for all new buildings; retrofit as funds become available
Innovative Wastewater Technologies	To reduce potable water demand and wastewater generation	Completed for Joint Use and Chinatown; effective immediately for all new buildings; retrofit as funds become available
Water Use Reduction	To protect natural habitat, waterways and water supply from pollutants carried by building discharge water.	Partially completed; ongoing work
Conservation of Materials and Resources	To reduce solid waste generated, meeting or exceeding State requirements to recycle 75% of solid waste generated and to purchase products/materials with 40% recycled content.	Implemented through District and Solid Waste Management Program; provide annual progress reports
Sustainable Purchasing and Procurement	Meeting or exceeding State requirements to purchase products/materials with 25% recycled content	Completed for Joint Use, Chinatown; annual reports from Building and Grounds Dept. and Purchasing Dept.

Toxic Material Source Reduction: Reduced Mercury in Light Bulbs	To establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into buildings through purchases of light bulbs	Mercury light bulbs no longer purchased; replace existing bulbs as funds become available
Sustainable Cleaning Products and Materials	To reduce the environmental impacts of cleaning products, disposable janitorial products, and floor coating products	Partially completed; ongoing as funds available
Internal/External organization materials & equipment reuse program	Institute a materials and equipment reuse program,	Completed; implemented via Recycling dept., Purchasing, Buildings and Grounds, and Food Services
Reduction in Paper Usage	All paper procured by the District will contain at least 35% recycled material	Ongoing via Purchasing Dept. and Duplicating Services; encourage 2 sided copying
Food Purchasing	The College will pursue a sustainable food purchasing policy to encourage sustainable farming and socially sustainable labor practices.	50% local & sustainable in the Cafeteria / TasteBuds in 2 years, 75% in 4 years and 95% in 6 years. In the PCR, 95% in less than a year.
Energy Conservation Program	To maximize energy performance in buildings and to exceed Title 24 - 2001 California energy efficiency standards	Completed for Chinatown, Joint Use; ongoing for new buildings; retrofits as funds become available
Operations and Maintenance Program	To implement cost-effective procedures and practices to ensure that all College facilities and building systems are reliable, safe, and energy efficient	Partially completed; ongoing work
Alternative Transportation	To reduce pollution and land development impacts from automobile use	5 – 10 years; completed; annual progress reports
Building Operations and Maintenance	To support appropriate operations and maintenance of buildings and building systems so that they continue to deliver target building performance goals over the long term	Partially completed; ongoing work
Performance Measurement: Emission Reduction Reporting	To document emission reduction benefits of building efficiency actions, retire a portion of the reductions and reduce emissions in the supply chain	Conduct survey in 2012 as funds become available

Appendix 2: Sustainability Plan Part 2

PLEASE REFER TO PART 2, CIRCULATED SEPARATELY, FOR THE FOLLOWING:

OVERVIEW (of Part 2)	Introduction to Part 2
	How This Plan Will Be Implemented
	Building CCSF Capacity for Sustainability Implementation
Chapter 1	Professional Development
Chapter 2	Instructional Programs
Chapter 3	Student Services and Student Communications
Chapter 4	Community Partnerships
Chapter 5	Social and Economic Sustainability



CITY COLLEGE OF SAN FRANCISCO (CCSF)

Building Information Modeling (BIM) Standards
for Design-Bid Build Projects

CCSFBIMS
Version 1.0

Prepared by:
CCSF Facilities Planning & Construction (FPC) Department
May 2011

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CCSF BIM Standards

1 Introduction

1.1 CCSF's Building Information Lifecycle Vision

The National Building Information Modeling Standards (NBIMS) Committee defines Building Information Modeling (BIM) as:

"...a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder."

Building Information Modeling (BIM) goes well beyond geometry, spatial relationships, light analysis, geographic information, quantities and properties of building systems, assemblies and components. BIM spans all aspects of the entire building life cycle, including but not limited to Needs Analysis, Capital Planning and Management, Construction Delivery Methods Design, Procurement, Construction, Repair, Maintenance, Sustainability, Renovation, Operations, Space Management, Deconstruction/Reuse. It addresses not only form, fit and function but activities that are traditionally not addressed with 2D or 3D CAD/Visualization.

The California Community College Chancellor's Office has committed to integrating Building Information Modeling (BIM), Facility Management and Geographic Information Systems (GIS) with the implementation by connecting 71 million square feet of facilities through BIM, FM and GIS using the ONUMA Planning System. The Foundation for CCC is also initiating other open standard systems: Facility Management, Computerized Maintenance Management (CMMS), BAS (Building Automation Systems), EMS (Energy Management Systems) and classroom scheduling that take advantage of this technology.

The City College of San Francisco (CCSF) is committed to adopting Building Information Modeling (BIM) incrementally and utilizing this enhanced technology to improve the design and management of CCSF's new and existing buildings across their lifecycles—from concept to design to construction to operations to reuse and eventual demolition. The goal of conversion to BIM is to reduce the Total Cost of Ownership at CCSF and, deliver higher value and maximize lifecycle building performance to support CCSF's mission to deliver excellent educational service to the Community.

The CCSF BIM Standards for Design-Bid-Build Projects have been developed to define a process and establish requirements, procedures and protocol for the utilization of BIM in the various stages of our projects. These Standards are based upon the National Building Information Standards (NBIMS) and reference the current technology Standards developed by the General Services Administration (GSA), the US Department of Veterans Affairs (VA), and Industry Foundation Class (IFC) by the International Alliance for Interoperability (IAI) and OmniClass Construction Classification (OmniClass) as developed by the Construction Specifications Institute (CSI) and the United States National CAD Standard (NCS).

Additionally, as guidance and reference, in preparation of its first BIM Standards, City College of San Francisco (CCSF) has adapted information developed for Los Angeles and San Diego Community College Districts' BIM Standards.

1.2 Objectives of CCSF BIM Standards

CCSF BIM Standards' intent is to facilitate the use of BIM technologies and workflow process to achieve the following:

- Facilitate a collaborative project environment between all parties, with better information and visualization for better intelligence and better decisions at any stage of the building lifecycle by integration of computer models into project coordination, simulation and optimization.
- Define BIM modeling and analysis requirements through development of open and shared standards for BIM process.
- Establish a technology platform to support incorporation of future technologies.
- Improve the quality of the design solutions and exchange of information between parties to obtain coordinated project documents through use of parametric and 3D BIM model.
- Improve systems coordination and the execution of design intent in the field for streamlined fabrication and construction processes, and minimized change orders.
- Utilize 4D BIM technologies for virtual simulation of construction processes with various trade contractors to better manage design-to-construction transition to avoid conflicts and improve efficiencies in the field.
- Utilize 5D BIM technology and processes to implement a Total Cost of Ownership Model and develop building life-cycle cost projections and accurate project cost estimates.
- Incorporate as-built BIMs, including infrastructure and building systems, into District wide Geographical Information System (GIS)
- Use BIM as Information and Communication tools for shared governance, students, facility managers and staff, and the Community.
- Enable the long term viability and usage of the BIM database through facilities, energy management and other lifecycle solutions software.

2 BIM Process & Implementation

2.1 General

CCSF requires development of a BIM Execution Plan (BEP) at project initiation to provide a master information / data management plan and assignment of roles and responsibilities for model creation and data integration. This is for use as a guideline to incorporate BIM as an integral part of CCSF's design, construction and facilities management processes. Through this process, the team members and CCSF project management shall jointly agree on how, when, why, to what level, and for which project outcomes BIM will be used in DBB (Design-Bid-Build) projects.

This document contains guidelines for implementation of certain BIM processes that may be new to the Project Team. Any deviations to the guidelines outlined herein must be documented by the Project Team, and then reviewed and approved by CCSF prior to commencement. As technology progresses CCSF will work with project teams to update these requirements accordingly.

2.2 Design Phase BIM Workflow

- a. Lead designer, Architect or Engineer, shall assign a Design Team BIM Manager to coordinate BIM workflow per section 3 (BIM Roles & Responsibilities) of the CCSF BIM Standards.
- b. Designers shall use trade specific analytic and authoring tools and software for creation of 3D models to meet predefined project requirements.
- c. BIM Manager will integrate the design discipline and trade specific models into a design (composite) model for spatial coordination, using coordination software (Navisworks, Bentley, etc.). The composite model will be used for assembling the various design and system models and generating a report and view list of design coordination issues.
- d. Spatial conflicts during the design phase will take place during coordination meetings, where the Design Team will electronically identify, track and publish interference/clash reports between all trades. The coordination software will be used to resolve all interferences interactively by the design team.
- e. Spatial Coordination Sign-off shall occur once all spatial conflicts, identified during the trade coordination and clash detection steps, have been resolved by the design team and the architectural, structural, MEP-F and Civil systems have been fully coordinated. Each consultant then shall provide fully annotated drawings of their respective systems in PDF format for submission to the Architect or Engineer of Record for review and approval.
- f. Fully coordinated design model shall serve as reference model for the construction team to coordinate fabrication models compliance with design intent, and shall be updated in a timely manner to reflect design changes in the field.
- g. Design Team shall regularly update building performance and energy models using BIM data as reference. Information generated from Design Energy models shall be integrated into design models as appropriate to achieve building performance and energy efficiency goals of the project.
- h. Currently it is not required to submit a BIM model to DSA; however CCSF will support development of DSA review and use of digital models in the future.

2.3 Bidding Phase BIM Workflow

- a. Design Team and CCSF, as part of traditional 2D documents delivered, shall provide to potential bidders non-editable version of the fully coordinated BIM for reference and visualization of the building.
- b. After contract award, the coordinated Design BIM and all native BIM files will be provided to the General Contractor.

2.4 Construction Phase BIM Workflow

- a. Applicable Construction Trades (or subcontractors) shall generate digital fabrication models for spatial coordination and shop drawing development.
- b. Contractor's Fabrication models shall be coordinated with the design model. Any conflicts to the design model that need to be made prior fabrication and construction shall be reported to Design Team in the form of an RFI. CCSF recommends that clash reports General Contractor issues clash reports as background information for RFIs and submittals.
- c. As part of the record deliverable requirements Design and Construction Teams shall continually update the Federated (Record) BIM with as-built conditions, and shall incorporate documented design changes in the field.

2.5 Design BEP (BIM Execution Plan)

The Design Team shall submit their BIM Execution Plan to CCSF for review and approval as part of their proposal. The BMP shall contain the following at the minimum:

1. Strategy as to how Design BIM will support the DBB project delivery activity.
2. Overall plan for compliance with CCSF BIM requirements.
3. Proposed BIM Software to be used by each technical discipline team member.
4. Proposed schedule aligned to BIM development and progress submittals per CCSF Submission Standards. Schedule to include:
 - a. Software compatibility testing (if required)
 - b. Proposed BIM workshops and training as needed
 - c. Progress BIMs per Design Document Submission
5. File formats used for project submittal and file exchange.
6. File exchange protocol.
7. Strategy for establishing and managing shared file server, if any (if a CCSF project not using a shared file server, provide the strategy for model exchange & handover)
8. Strategy for import of space and equipment information (i.e. from FUSION) and export for Facility Management and Operations.
9. Strategy for COBIE integration.
10. Energy modeling and sustainable strategies, analysis and verification.
11. Strategy for updating and coordinating design changes during construction using BIM.
12. Documentation of any proposed deviation from BIM Standards for THE DISTRICT consideration.
13. Legal status of the Design Model for construction (Binding, Informational, Reference, Reuse)
14. BIM qualifications, contact information of the project team, and a list of individuals with relevant experience assigned to the following roles:
 - Design BIM Manager (ref. Section 3.3.1)
 - Mechanical System BIM Coordinator (ref. Section 3.3.2)
 - Lead BIM Technicians for all major trades (i.e. Architect, Civil, MEPF, Structural)
 - Senior Project Designer(s) and Engineer(s)
 - BIM and IT Managers for all applicable trades

2.6 Construction BEP (BIM Execution Plan)

Contractor shall submit a Construction BIM Execution Plan in the bid outlining their strategy for utilizing BIM technology to execute construction related activities and project coordination. The Construction BEP shall address the following:

Comment [f1]: LACCD requires BEP after bid and contract award

1. Proposed strategy as to how the Construction BIM will be utilized during the construction phase to support the DBB project delivery activity including:
 - Specific strategy for the Design BIM reuse.
 - Constructability analysis with BIM: Trade coordination strategy (clash detection) and use of digital fabrication.
 - Utilization of 4D scheduling and sequencing / phasing technology.
 - Updating as-built conditions in Federated (Record) BIM during Construction.
 - Strategy for updating and coordinating changes during construction into the final BIM deliverable.
2. List of sub-contractors using digital fabrication.
3. Proposed BIM Workshops and Training integrated into project schedule.

4. Integration of construction changes and commissioning data into BIM.
5. Strategy for COBIE integration and submittals.
6. Documentation of any proposed deviation from BIM Standards for the District's consideration.
7. Identification of the legal status of the Design Model to construction: Binding, Informational, Reference, Reuse
8. BIM qualifications, contact information of the construction, and a list of individuals with relevant experience assigned to the following roles:
 - Construction BIM Manager (ref. Section 3.4)
 - Lead Fabrication Modelers for all trades in Section 3.3.

3 BIM Roles & Responsibilities

3.1 Owner's Virtual / BIM Project Manager

The Owner will direct and oversee the building information modeling efforts of the project during design and construction, via its virtual project (BIM) as part of CCSF's Facility Planning and Construction (FPC) Department. This individual will have knowledge of BIM technology and how it can support the needs of the owner organization; from setting standards for BIM knowledge (for project team's use) to knowledge of how to use model for facilities management and operations, and to contracts for integrated practice. Owner's virtual project / BIM manager will serve as the main point of owner contact for the Design and Construction Teams for BIM related issues.

It is the responsibility of all Design Consultants and Contractors to have or obtain, at their cost the trained personnel, hardware, and software needed to successfully complete the BIM coordination phase of the project. Equipment used by the subcontractors during the onsite coordination meetings must meet the requirements of the software being implemented so as not to cause delays in modeling or redraw. Individuals assigned to the following project roles shall have the below outlined minimum qualifications and responsibilities:

3.2 Design Team BIM Manager

As part of the Design BEP, the Design Team shall assign an individual to the role of Design Team BIM Manager. The individual shall have sufficient BIM experience (minimum 3 years preferably) for the size and complexity of the project and shall have relevant proficiency in the proposed BIM authoring and coordination software. This individual and his/her qualifications shall be approved by CCSF and shall serve as the main point of contact with CCSF and the Project Team for BIM related issues. Assigned responsibilities shall be as follows:

1. Ensure compliance with the approved Design BEP (BIM Execution Plan).
2. Coordinate project-wide training sessions with CCSF Virtual Project (BIM) Manager
3. Coordinate software training and team file management.
4. Provides specifications for "BIM Work Room" to CCSF for approval.
5. Facilitates BIM Technical meetings with Lead BIM Technicians.
6. Ensure Design Team understands, supports, and meets CCSF Vision and Main Objectives for BIM (ref. Section 1)
7. Coordinates the set up of shared file server with Design Team IT staff. This shall include interfacing with Design Team IT staff to set up web portal, permissions, etc. If there is a District wide portal, individual shall coordinate with District wide IT Administrator for permissions and set up.
8. Ensure the shared geo-reference points noted in Section 6.4 are distributed to and used by all team members.
9. Assembles composite design model for coordination meetings.
10. Provide Modeling Quality Control / Quality Assurance Check of Design BIMs.
11. Facilitates use of composite design model in design coordination / clash detection meetings and provides detection reports by the identification of all hard and soft collisions.
12. Ensure that BIMs are used appropriately to test design requirements and functionality criteria.

13. Interface with Project Team BIM and IT Managers to ensure software is installed and operating properly.
14. Interface with software developers to provide feedback and bug reports.
15. Interface with CCSF's Department of Facilities Planning and Construction for data and file exchange as needed.
16. Assure that the design deliverables specified in the contract are provided in accordance with the formats specified.
17. Coordinate BIM File Exchange and archiving of Milestone Submittals.
18. Assure COBIE information provided at milestone submittals and for the contractor.
19. Assure proper BIM-derived 2D information for paper printing is as required and conforms to the United States National CAD Standard (NCS).
20. Coordinate with the General Contractor / Builder to assure the proper creation of final deliverables.

3.3 Technical Discipline (Design) or Trade (Construction) Lead BIM Coordinators

All major design trades (architectural, structural, MEPF, etc.) shall assign an individual to the role of lead BIM Coordinator to coordinate their work with the entire Design / Construction Team. These individuals shall have relevant BIM experience (minimum 2 years preferably) and shall have the following responsibilities:

1. Coordinate technical discipline BIM development, standards, data requirements, etc. as required with the Design Team BIM Manager.
2. Lead the technical project team internally with their BIM documentation and analysis efforts.
3. Interface with Design Team BIM Manager for BIM related meetings, clash detection and resolution activities, and issues.
4. Coordinate internal and external BIM training as required.

3.4 Construction BIM Manager

As part of the Construction BEP, the General Contractor shall assign an individual to the role of Construction Team BIM Manager. The individual shall have sufficient BIM experience (minimum 3 years preferably) for the size and complexity of the project and shall have the ability to utilize the BIM software to help identify constructability issues. This individual and his/her qualifications shall be approved by CCSF and shall serve as the main point of contact between CCSF Virtual (BIM) Project Manager and Construction Team for BIM related issues. His / her assigned responsibilities should include the following:

1. Overall responsibility for the Construction BIM model creation and information developed during construction.
2. Prior to and during the Construction, coordinate the set up of shared file server with Campus IT to set up web portal, permissions, etc. If there is a District wide portal, individual shall coordinate with District wide IT Administrator for permissions and set up.
3. Ensure compliance with the approved Construction BEP (BIM Execution Plan).
4. Coordinate software training and establishes protocol software for Construction Team for efficient delivery of project.
5. Provides specifications for General Contractor's "BIM Work Room" to CCSF for approval. Ensure that the Construction Team has necessary hardware and BIM Software properly installed and accessible for project use.

6. Prior to commencing construction, coordinate construction sequencing and scheduling activities, and assure they are integrated with the Construction BIM.
7. Ensure Construction Team understands, supports, and meets CCSF Vision and Main Objectives for BIM (ref. Section 1)
8. Facilitate use of composite trade models in construction coordination / clash detection meetings and provides detection reports by the identification of all hard and soft collisions.
9. Communicate with the Design Team, coordinate the data extraction sets required by the construction trades and ensure that these requests are met.
10. Coordinate with the Design Team to facilitate design changes in the field have been documented and are updated in the Design Record BIM in a timely manner.
11. Prior to approval and installation, work with Lead Fabrication Modelers to integrate 3D fabrication models with updated design composite model to ensure compliance with design intent.
12. Coordinate update of as-constructed conditions in the Final BIM Model deliverable submittal to CCSF.
13. Ensure record documentation noted in Document Submission Standards are properly linked to Construction Record BIM for final submittal to CCSF.
14. Coordinate with Design Team and Commissioning Agent to assure COBIE information is complete.

3.5 BIM Assignment Matrix

A form to layout BIM Roles and Responsibilities Matrix shall be included in the BEP as an Appendix with the suggested information at the minimum, as follow:

- Project Name and Number
- School
- College Project Manager
- Firm / Company
- Discipline(s)
- Project BIM Manager (one per team)
- Lead BIM Coordinator Contact Info (one per firm/company)
- Software and version to be used
- Native and Exchange file formats to be used
- Other

3.6 BIM Deliverable Schedule

Following table represents the schedule of BIM deliverables that City College of San Francisco will expect from the project team based on specific project needs and requirements:

Milestone	Deliverable
Pre-Design	Massing Model
	Program Matrix
	Preliminary Energy Model
	Establish LEED requirement
Schematic Design	Program Validation
	LEED Scorecard
	Architectural Model
	Structural Model
	Civil Model
	Energy Model / Lifecycle Analysis
	Cost Estimate
	COBIE Design Data Worksheets
Design Development (Anticipated phases) 50% DD 100% DD	Program Validation
	Validated LEED Scorecard
	Architectural Model
	Structural Model
	Civil Model
	MEP-F Models
	Energy Model
	Cost Estimate
	COBIE Design Data Worksheets
	Initial Clash Detection Report
	Initial Lighting Analysis
Construction Documents (Anticipated phases) 50% CD 100% CD	Final LEED Scorecard
	Architectural Model
	Structural Model
	Civil Model
	MEP-F Models
	Final Energy Model
	Detailed Quantity Cost Estimate
	COBIE Design Data Worksheets
	Updated Clash Detection Report
	Final Lighting Analysis
Bidding	Architectural Model
	Structural Model
	Civil Model
	MEP-F Models
Construction (Contractor)	Discipline Specific Coordination Models
	Digital Fabrication Models
	Electronic as-Built / record BIM Markups
	Scheduling Model
	COBIE Construction Worksheets
Construction (Design Team)	Current As-Built Models for Each Discipline
Closeout	Final As-Built Models for Each Discipline

4 Project Team Collaboration Procedures

The success of a BIM enabled project delivery process is highly dependent upon the level at which the entire project team can communicate and work collaboratively for the duration of the project. This section documents collaboration procedures for effectively managing this process:

4.1 Model Sharing

Design

- Qualifications, experience and previous success in BIM coordination of the proposed BIM Manager and the Design Team shall be part of the evaluation of the AE selection.
- The Design Team shall be responsible for providing a fully coordinated and assemble BIM in a collaborative software format (Navisworks or equal) as well as separate copies of each technical discipline model in the original software authoring tool, as well as a 2d plan set, derived from the assembled BIM, for contract bidding.

Construction Bidding

- Qualifications, experience and previous success in BIM coordination and fabrication of the proposed Construction BIM Manager, General Contractor, and major sub-contractors to achieve CCSF's BIM objective shall be part of the evaluation of the Contractor selection.
- During bidding, the use of BIM Standards will be announced and reviewed with potential bidders, and then reviewed with the selected GC and major sub-contractors prior to the construction start.
- The Contractor shall have access to the Design BIM during bidding and construction phases of the project. The solicitation for bids shall define the legal status of the model to the bidders (binding, informational, reference, etc) by determining the Contract Record Document (the BIM Model(s) or the extracted 2D plan set). This decision will be made on the basis of CCSF business interests, the maturity of the market for BIM use, and other factors.
- Regardless of whether or not the Design BIM Model(s) is the Contract Record Document, after a contract is awarded for construction the coordinated design BIM and all native BIM files shall be provided to the appropriate contractor entities as needed.

Construction Phase

- It is the Contractor's responsibility to assure that all major trades are modeled and used for clash detection, construction phasing, and installation coordination.
- Contractor's fabrication models shall be coordinated with the design model. Any conflicts/changes to the design model that need to be made prior to fabrication and construction shall be reported to the Design Team in the form of a Request for Information (RFI). Clash reports may also be issued by the General Contractor (GC) as background info for RFI's and Submittals.

4.2 Shared File Server

Prior to start of the design, it is required that Design Team establish a single shared project server for the upload and exchange of digital models, and the collection of project deliverables at pre-determined milestones. The same shared server shall continue to be used for the same purposes during Construction. Models on this shared server will be fully accessible web-based to all project team members via assigned site

user names and passwords. If a CCSF provided shared file server is available, Project Team shall coordinate with the District to establish access and user permissions.

1. **Upload Models to Shared Project Server:** During the Design Phases, design engineers and architects will upload their discipline-specific authoring and analysis BIM models to the shared Project Server for scheduled coordination meetings and milestone submittals.
2. **Design:** BIM Design Models uploaded for clash detection and systems coordination should be saved in an optimal interoperable format agreed upon by project team. (Navisworks accepts several file types but dwg, nwd/nwc, and ifc are file formats that are operable across multiple software platforms)

4.3 Project Kickoff BIM Standards Orientation Meeting

After the project is awarded to the Project Team, CCSF shall facilitate a BIM Standards Kickoff Orientation with the Design Team to review the following:

- It is the Contractor's responsibility to assure that all major trades are modeled and used for clash detection, construction phasing, and installation coordination.
- CCSF BIM Standards and Workflow Process
- Statement of Owner's Project Requirements
- All data developed during the project validation phase
- Project Model Template

Use of BIM Standards will be announced to potential bidders during bidding phase, and then reviewed with the selected GC prior to construction start.

4.4 BIM Workroom(s)

A BIM Workroom or Coordination room shall be provided and utilized as a collaborative work environment during design and construction for facilitating BIM design review and clash detection/coordination where all team members can meet to discuss technical discipline coordination issues using the BIM Models. Alternatively, collaboration using web conference (i.e. WebEx, GoToMeeting) is acceptable for facilitating these meetings.

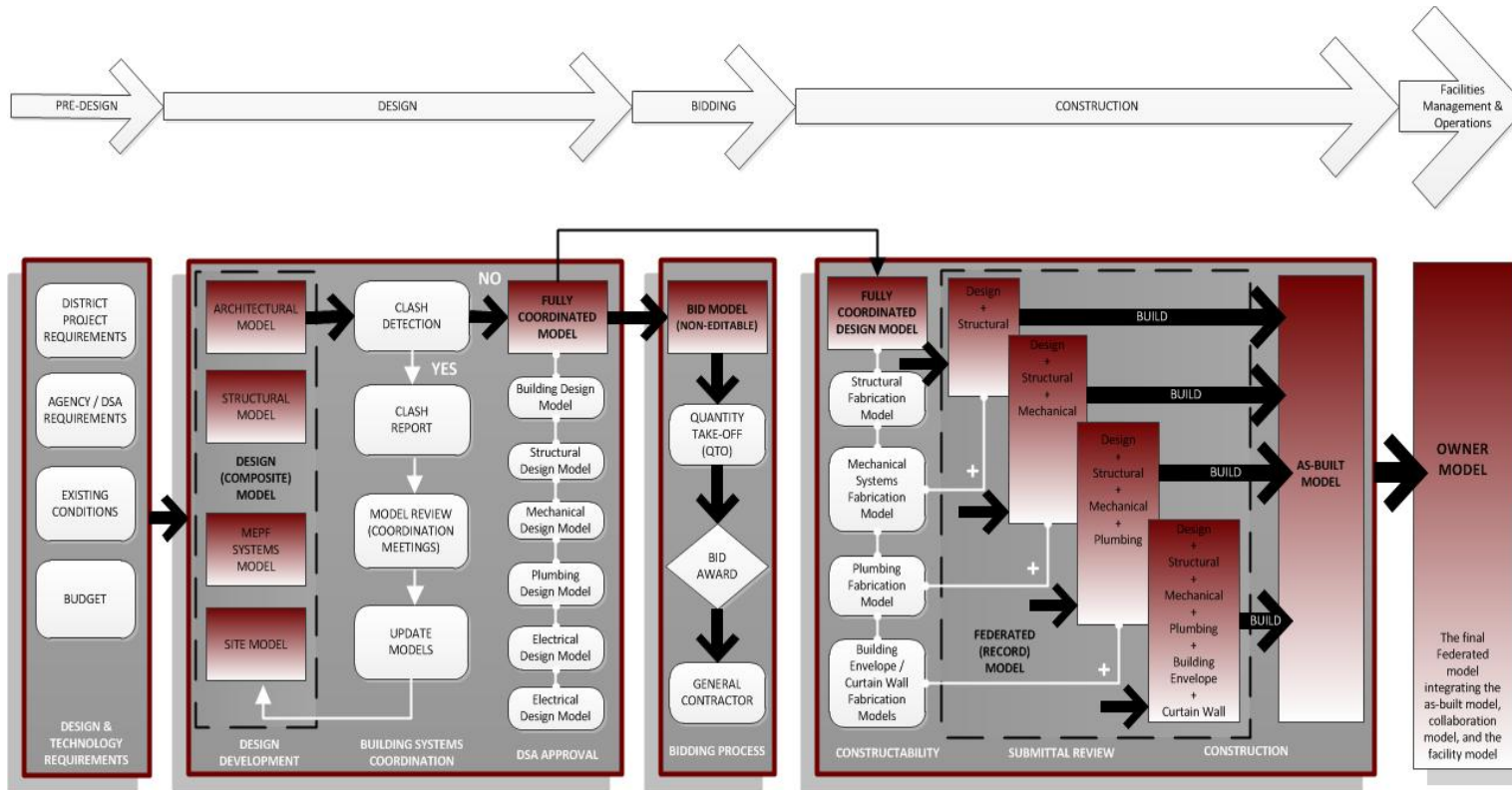
During the Design phases, the Design Team Prime Consultant will provide the BIM Workroom for facilitating the collaboration. During Construction, Contractor will provide and set up a BIM Collaboration room located at or near the construction site to coordinate fabrication models with respective trades.

Smart boards may be used to view 2D and 3D documentation, create mark-ups interactively, archive the latter, and convert them to RFI (Request for Information) 's or other relevant reference documents.

4.5 Spatial Coordination & Clash Detection

To facilitate spatial coordination and clash detection in a 3D environment, in addition to authoring and analysis tools specialized coordination software such as Navisworks, Bentley Navigator and etc. will be needed.

Following page represents City College of San Francisco's BIM Collaboration Workflow for Design-Bid-Build Projects:



BIM COLLABORATION WORKFLOW FOR DESIGN-BID-BUILD (DBB) PROJECTS

Building Information Modeling (BIM)
February 2011



- a. **3D Models, Formats and Model Structures:** The BIM(s) shall consist of 3D-Solids (not lines or wire frames) that represent the actual dimensions of the building elements and the equipment that will be installed on the project. Reasonable abstractions can be made (i.e. pipe fittings do not need to be modeled) in the Design Model, and these abstractions shall be coordinated later on with the Constructor to ensure meaningful coordination and clash detection. Before modeling begins, BIM Manager will work with the team to develop a structure and features of the files that are to be submitted: File Structure, Modeling Scope Matrix. Typically, BIM Coordination requires the following model structures and features:
1. Project team shall follow CCSF File Naming requirements as described in CCSF BIM Standards Section 7.1.
 2. The BIM Manager shall establish the floor elevation protocol so that the Technical Discipline/Trade BIMs will be modeled at the correct elevation.
 3. Clearance Reservations: All models shall include separate 3D representation of required clearances for all mechanical equipment for repair, maintenance, and replacement, light fixture access, overhead cable tray access, etc. These clearances/access models should be in a separate layer(s) for each trade clearly labeled as such.
 4. All elements of the building must be represented in only one file and should be modeled by their specific trade. For example, the architectural model provided for 3D coordination should not include any of the structural elements contained in the structural model. Light fixtures should be modeled by the electrical engineer, not the Architect.
 5. Architectural ceilings should contain openings for lights, registers, etc. as required.
 6. The granularity of elements in the model shall reflect the proposed sequence of the installation at the site (e.g. not one single wall element for the entire floor). This will also support the 4D visual sequencing of the construction.
 7. All 3D model files submitted for clash detection must be “clean”; all extraneous 2D references and/or 3D elements must be stripped from the models.
 8. When emailing notifications of file uploads or for any other email correspondence pertaining to the project, all email subject line headings must be prefaced with the acronym for the Project Name.
 9. For ease of identification during the 3D Coordination process, the following trades will be represented in these assigned colors (for the Coordination Software:
 - Architectural: White
 - Communication Conduit: Light blue
 - Electrical Conduits: Light yellow
 - Electrical Cable Tray: Dark Orange
 - Electrical Equipment: Dark yellow
 - Electrical Lighting: Yellow
 - Fire Protection: Red
 - HVAC Equipment: Gold
 - HVAC Supply Duct/Diffuser: Light blue
 - HVAC Return Duct/Diffuser: Magenta
 - HVAC Pipe: Gold
 - Structural Steel: Gray
 - Structural Concrete: Gray
 - Plumbing Water: Cyan

- Plumbing Sewer: Magenta
 - Plumbing Storm Drain: Green
 - Pneumatic Tube: Dark green
- b. **Subcontractor Coordination:** When planning the installation process, prior to installation, the Contractor shall hold trade coordination meetings with subcontractors, where the coordinated model will be used to review and optimize field installation. Subcontractors will be expected to have individuals attend who can actively engage in the planning process and make schedule commitments.
- c. **Digital Fabrication:**
The collaborative process will ensure that the deep knowledge and associated efficiencies of the fabricator are embedded into the Construction Model(s). The following construction trades (at a minimum) shall provide models with parametric model objects:
- Structural Steel
 - Curtain Wall
 - Mechanical System Duct (MEP subs to incorporate vendor models if available)
 - Building Envelope Systems (i.e. sun / rain screens, pre-cast panels)
 - Casework and furniture systems
 - Any additional fabrication models generated by subcontractor
- d. **Coordination of entire building:**
BIM Manager will assemble a composite model from all the model parts of each design discipline for the purpose of performing a visual check of the building design for spatial and system coordination. Vertical shafts should also be reviewed to ensure that adequate space has been allocated for all of the vertical mechanical systems and that all of the shafts line up floor to floor.
- e. **Floor by floor coordination:**
On a multi-level project, the models may need to be split on a level by level basis for MEP coordination. If a floor is particularly large, it may also need to be split by zone to reduce file size. Each floor shall be created as a separate level in the coordination software, and all trades shall reference a shared and documented insertion point and methodology for developing these files. Typically, 3D coordination continues single floor until building systems are fully coordinated, and then continues on the next floor up.
- f. **Clash detection and reporting:**
1. Coordination software will be used for assembling the various design models and for providing a report and view list of design coordination issues. The Design Team, including Team BIM Manager and discipline BIM Lead Modelers, will review the model and the Clash Reports in coordination meetings on a regular (weekly) basis.
 2. The report will be reviewed by the team members and agreed upon solutions will be implemented per an agreed upon schedule. This process will be repeated throughout the design phases until all spatial and system coordination issues have been resolved.
 3. During the construction phase, the Contractor shall utilize the fully coordinated and consolidated design model to verify the accuracy of certain fabrication models. Prior to each fabrication submittal for approval, fabrication contractors

- shall submit their models to the Contractor's BIM Manager for integration with Design Model.
4. Internal Clash Resolution: Design Consultants and Subcontractors who are responsible for multiple scopes of work are expected to coordinate the clashes between those scopes prior to providing those models to the BIM Manager for spatial and system coordination.

5 CCSF Requirements for Using BIM

BIM can be utilized in a variety of ways to provide stakeholders with a greater understand of how a building is to be used, designed, constructed and maintained. Following are the various applications in which BIM shall be utilized for all CCSF BIM projects:

5.1 Design-Bid-Build (DBB) Workflow

In the traditional DBB project delivery method, when there is no contractor or subcontractor in the design process, an Integrated Design Process shall be implemented. This process integrates people, systems, and business practices into a collaborative process (utilizing previously described project team collaboration tools and procedures) that optimizes efficiency through all phases of the project. The team includes disciplines and stakeholders who remain involved from start to completion.

- A Design Team BIM Manager and BEP (BIM Execution Plan) should be developed prior to modeling.
- Architectural and building systems models will be developed by Design Team
- The Design BIM Manager will integrate discipline models into a composite file which will be used for coordination and clash detection.
- Interferences will be resolved interactively during the coordination meetings as described further in Section 4.5 of the CCSF BIM Standards.
- Construction documents will be printed for agency (DSA) approval once all conflicts are resolved.
- Models will be made available to bidders for reference only.

5.2 Space Validation (Pre-Design & Programming)

Programming requirements defining area, adjacencies, building systems and furnishings shall be integrated into the BIM Authoring Software. These requirements shall be based on City College of San Francisco Standards, the campus Education Master Plan and Facility Master Plan, and shall reference the applicable District Basis of Design and Sustainable Design Guideline Documents, if available. BIM shall be used for reference and verification purposes throughout the design process. As-built records of existing facilities, and BIM / GIS mapping of campus shall be included in this document and provided to project teams for their use during RFP phase, if applicable. Where possible, all programming and as built data provided by the campus shall be in a format that is translatable to an IFC Compliant BIM Authoring Tool and shall be expected to be incorporated by the teams in their design processes for reference and verification purposes.

5.3 Site Conditions (Existing & New Construction)

Modeling of the project site and the existing structures shall be part of the BIM requirements for new and renovation projects. Depending on the project site, a model of the site may already be available and obtained from the CCSF Vault or

commissioned by an external BIM consultant using an approved IFC compliant, 3D site and utility modeling tool.

The modeling of existing buildings shall be performed based on CCSF provided as-built information, with field verification or electronic measurements conducted by Project team to validate the level of accuracy. For existing conditions to be directly impacted, altered, or to be demolished by a proposed renovation, Project Designers shall model those conditions to the appropriate level of detail that will clearly demonstrate the design intent to building user and other stakeholders, other Project Team Members, and construction trades directly involved with executing the alteration.

5.4 Architectural (Spatial & Material Design) Models

The Architectural Spatial model evolves during the design process, and the information modeled in BIM shall be further refined as a project progresses toward construction. In the early phases of design, an Architectural BIM Model may be as simple as a massing model validating program requirements, basic geometries, and building orientation to climate and site conditions.

Design options shall develop and need to be clearly documented and delineated in the BIM model as the design progresses. Likewise, as materials and components are selected, generic assemblies shall be assigned material properties, sizes, track LEED values, and other specific component information to clearly define various building features such as walls, floors, roofs, doors and windows. Program space requirements shall be modeled in the spatial model and validated using schedules and other validation tools designated by CCSF for the specific project.

The timing of the Level of Development (LOD) required for element(s) or system(s) will be dependent entirely upon the project execution strategy used for the project, as the deliverables and their timing will be different for DBB than for DB or IDP (Integrated Project Delivery). LOD's and the Model Progression Specification (MPS) that they are established by will be further discussed in section 6 of CCSFBIMS.

5.5 Building System Models (Structural, MEP-F and Interiors)

Design information for the above is required to be developed in BIM as current technology allows building systems to be organized as separate BIM models linked to a common campus benchmark for efficient and accurate coordination purposes. Similar to the spatial models, the level of detail in these models shall evolve as design progresses such that these systems are accurately modeled, and include sufficient performance, clearance, and LEED requirements as part of the BIM.

5.6 Energy & Life-Cycle Cost Analysis

All new construction shall need to be designed in a way that energy and material use can be greatly reduced and then measured and verified by a building's users and facility management and operation teams once it is occupied. BIM provides the opportunity to simulate energy consumption of the building based on different scenarios and allow life-cycle cost calculations based on the information extracted directly from BIM model.

Comment [f2]: 1.1 Energy Modeling Requirements

The Design Team shall work with the District to establish project specific energy goals and energy use targets. The Design Team shall also establish an energy modeling methodology that will be included within the BIM Execution Plan that will detail how energy modeling will be accomplished for the project. At a minimum, the required software to perform the energy modeling for the project shall be any software as listed acceptable by the US Department of Energy, Energy Efficiency and Renewable Energy. A list of approved software can be found at the following link:

http://www1.eere.energy.gov/buildings/qualified_software.html. In addition to this list, the designer may also use the following DOE 2 based software: Green Building Studios, Ecotect, eQuest. Local weather data shall be obtained from TMY2 or TMY3 weather data tables. Weather files can be downloaded from the National Renewable Energy Laboratory website at the following link:

http://rredc.nrel.gov/solar/old_data/nsrdb/tmy2/.

The energy model is developed in two parts. The preliminary (conceptualization) energy model is prepared as a part of Schematic Design. The preliminary energy model's purpose is to narrow down design strategies from the multitude of design possibilities to those that are in line with and will achieve the projects energy goals and targets.

The second part of the energy model is developed in the Design Development phase. The Design Development phase energy model shall build upon the model developed in the Schematic Design phase. This energy model shall be complete enough to use for additional submissions, such as LEED EA Credit 1 calculations, should the building apply for LEED certification. This model shall be detailed and finalized enough to use as an indicator of approximate building energy use after occupancy. This model shall also serve as a baseline for future comparisons. After building completion and occupancy of a minimum of one year, actual building performance shall be evaluated against this model. This model shall be used as a tool to facilitate post-occupancy commissioning should discrepancies between modeled and actual energy use arise. Caution is advised in this, as deviations from design in weather, occupancy, plug loads, schedules, electric and fuel costs, etc. will affect actual energy use, and these factors must be taken into account.

The Design Team shall work with CCSF to establish project specific energy goals and targets. The purpose is to narrow down design options to those that achieve the project's energy goals and target.

1. **Schematic Design:** Energy model at this phase shall be used to evaluate design strategies and improve the long term energy performance of the building. The schematic design energy model shall include and incorporate at the minimum: floors, roofs, exterior and interior walls defining zones of similar use, ceilings, openings, doors, overhangs and sunshades; building function and occupancy, operating schedule, lighting information, HVAC equipment information, plug / process loads, local weather info and building envelope components. Below are the analysis requirements:
 - Energy calculations via use of eQuest, EnergyPlus or other energy calculation software.
 - Building lifecycle estimate of energy consumption for the projected life of the project (40 years based on year of occupancy and escalate at the current CPI rate, including first cost, estimated service life, annual maintenance cost and operating cost.
 - Massing studies to enable whole building energy analysis to make decisions about how the building is placed on the site and spaces are configured. Design team shall submit to CCSF, in spread sheet format, the list of design options and comparison results with annual energy usage in kWh and cost in dollars.
 - Energy performance evaluation of construction elements including walls, roofs and windows. Design team shall submit to CCSF, in spread sheet format, the list of design option and comparison results (via iterations by changing one component at a time), and shall include annual energy usage in kWh and in cost dollars.

2. **Design Development:** Energy model at this phase shall be based on the schematic model. Accuracy obtained at this level should be enough for energy calculations and for use as an indicator of approximate energy usage after occupancy. Building data shall be extracted from the BIM Model directly and be utilized for below analysis:
 - Assess space and building energy performance for compliance with regulations and targets.
 - Perform more advances analysis to evaluate daylight design options to achieve maximized energy savings over the building lifecycle.

3. **Construction Documents:** Energy model at this phase shall reflect the final design, and be complete enough to use for final energy calculations for submittal and be used as an indicator of approximate building energy usage after occupancy. As analysis requirement, building energy performance shall be confirmed as in compliance with regulations and targets.

5.7 Cost Estimation

Area, system information and quantity takeoff information generated from the Project BIM, via authoring software and other BIM integrated tools, shall be used for estimating

purposes at project milestones as defined by the contract. At the completion of Construction Documentation Phase, the Design Team shall provide to potential bidders a copy of the fully assembled and coordinated BIM in a non-editable format.

5.8 4D Scheduling & Sequencing

The construction planning process requires the sequencing of activities in time and space and accounting for constraints such as resources, spatial constraints, logistics and similar. Because traditional scheduling methods do not address the spatial aspect of construction nor are they linked to a design or building model directly.

Traditional bar charts and CPM network diagrams can be difficult to understand or interpret. BIM, on the other hand, allows linkage of the model with an external schedule, and will allow the Construction Team to visualize the construction virtually, giving the team improved accuracy in construction sequencing and coordination (build before building). The main elements that CCSF requires for 4D simulation and sequencing shall be as follow:

- **Site work and ground level:** Excavation work, footings, foundations, slab-on-grade
- **Structural System:** Entire system inc. foundation, grade beams, columns, load bearing walls, floor and roof decks and support
- **Exterior Building Shell:** Walls /curtain walls, openings, glazing, panel assemblies
- **Interior Core:** Walls, main plumbing walls and wall assemblies
- **Roof System:** Roof assembly, major equipment and openings
- **Mechanical System:** Main ductwork and equipment separated by floors
- **Plumbing:** Main connection lines from site, main plumbing lines

5.9 Communication of Construction Scheduling and Phasing

The optimal way in 4D scheduling is to import schedule activity data from scheduling software as Primavera P3 or P6 into a dedicated 4D scheduling application and “link” the activity data to the associated object in a 3D model. The result is a 4D model which provides a value advantage to the Project Team for better visualization and coordination of the construction sequence for respective trades.

For design work that includes sequencing of renovation swing space or master planning for long-term build-out, BIM 4D shall be used to illustrate the phasing plan to interact, communicate and get approval of the final design and spatial sequencing with the educational staff.

The Contractor shall link BIM to the project schedule also to animate the phasing plans to address issues like shut downs of required/impacted facilities (inc. adjacent neighborhood, cities and agency coordination), swing space during construction, parking interruptions, and re-routing of pedestrian and vehicular traffic, or any other construction work that could affect the daily operations of the school and campus-life.

5.10 5D Estimation

CCSF will not require BIM based 5D Estimation at this time; but will address this requirement in later versions of its standards as technology progresses.

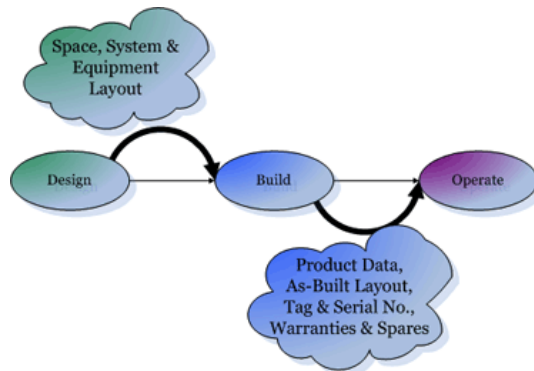
5.11 Design Visualization

Design visualization tools refer to animations, fly-throughs, static 3D renderings, 4D, and 3D Physical Models exported directly from a BIM Authoring Tool. Design teams shall participate in providing the quality design visualizations that illustrate building spaces, their use and organization to assist end-users and other project stakeholders in making decisions throughout the project duration. Visualization models may be developed by the Contractor during the Construction to help simulate and sequence construction of a single room or a floor or the whole building before it is built.

Further refinement in specific animation and visualization software may be needed to accomplish needed results even though BIMs will contain most of the source information.

5.12 COBIE (Handover to FM) / Commissioning

CCSF has adopted COBIE or “Construction Operations Building Information Exchange” as the methodology to electronically transfer building information after construction is complete for facilities management and operations. The data required by COBIE is the same information as is currently required by project handover specifications. With COBie approach data is created during the design, construction and commissioning process, see following.



(Source: <http://www.wbdg.org/resources/cobie.php>)

The COBie spreadsheet is part of the U.S. National Building Information Model Standard (NBIMS). Third-party utilities facilitate the automatic creation and transfer of some data between BIM and a COBie spreadsheet via IFC files as an intermediate stage, and some BIM software may include creation of and data transfer to the spreadsheet directly without making use of intermediate IFC files. Where possible, automatic means should be used to create and fill in the COBie spreadsheet.

CCSF will use the [COBie2 specification \(DOC\)](#) which provides a vendor-neutral, non-agency specific, open standard specification clause for use within the existing contract specification. This specification requires the delivery of COBie2 data in the Spreadsheet XML 2003 format at each appropriate stage of the project's life-cycle. The COBie2 specification will be implemented, not as a stand-alone or BIM-based specification, but within the context of the existing specifications.

As with all design related information, the lead Architect/Engineer firm is responsible to coordinate the compilation of all COBie2 information into a single COBie2 deliverable file when the deliverable is required during design. In the case of construction related information, the prime contractor is responsible for the delivery of a single COBie2 deliverable file when the deliverable is required during construction. The Design / Construction Team are encouraged to provide as much information in COBie as is known at the time of the deliverable. The required worksheets in COBie will be filled out in step with the LOD and Design Phases. The following shows COBie2 worksheets that shall be provided with required submittals:

Project Phase	Required COBie2 Worksheets
Schematic Design	<ul style="list-style-type: none"> • (1) Contact Worksheet • (2) Facility Worksheet • (3) Floor Worksheet • (4) Space Worksheet • (5) System Worksheet
Design Development	<ul style="list-style-type: none"> • Updated Worksheets (1-5) • (6) Register Worksheet • (7) Component Worksheet
Construction Documents	<ul style="list-style-type: none"> • COBie data shall be updated and provided at the CD submittal
Construction	<p>Operational Planning Set to be provided at 75% completion or three (3) months prior to substantial completion, whichever is earlier. This set shall be an update to the design team COBIE worksheets and include the following COBIE worksheets:</p> <ul style="list-style-type: none"> • Updated Worksheets (1-7) • Document Worksheet (11) • Component Worksheet (7) • Installation Worksheet (14) • Manual Worksheet (15) • Warranty Worksheet (16) • Spare Worksheet (17)
Beneficial Occupancy	<p>This set shall be an update to the Operations Planning Set and include the following COBIE worksheets:</p> <ul style="list-style-type: none"> • Instruction Worksheets (18) • Test Worksheet (19) • Certification Worksheet (20) • Material Worksheet (21) • Tool Worksheet (22) • Training Worksheet (23) • PM Worksheet (24) • Safety Worksheet (25) • Trouble Worksheet (26) • Start-Up Worksheet (27) • Shut-Down Worksheet (28) • Emergency Worksheet (29)
Fiscal Completion	updated previous phase information, as needed

(Source: Adapted from Building Smart Alliance and San Diego CCD BIM Standards)

5.13 Clash Detection/Coordination

Clash detection provides great opportunity to the project team for effective identification, inspection and reporting of interferences in a 3D project model. BIM Models are required to be clash free, and success of this process depends upon the level of team collaboration and open line of communication. It is the Design / Construction Team's responsibility to conduct and manage an adequate and thorough Clash Detection process so that all major interferences between building components will have been detected and resolved before construction.

It shall be the goal of the Design/Construction Teams to reduce the number of changes during construction due to major interferences to zero.

5.14 Virtual Testing & Balancing

The CCSF requires virtual testing and balancing of the architectural model to support sustainable building systems design and analysis. Room data can be read from the linked architectural model to create mechanical spaces (each space is the same as the room in the architectural model). Multiple spaces are joined to create zones. This data can be used to calculate native heating and cooling analysis that is built into the MEP-F software or exported using gbXML to an external analysis application such as eQuest, Trane/Trace, or DOE based analysis programs.

Architect / Engineers can then bring this data back within the data to check their work. One of the methods is to create a Space/Room schedule that will show calculated air flow versus actual air flow. All air flows can be checked for load balance to the terminal box and all the way back to the air handling units. MEP-F modeling software companies should be contacted for more information.

5.15 Additional BIM Uses

The CCSF is interested in and encourages bold steps toward trying new ways to improve business process efficiency, design, and project outcomes. Following are some of the discretionary areas that CCSF supports for further development and the use of BIM; other ideas may also be proposed by the AEC teams:

- Evaluating physical security and survivability
- Early MEP-F design
- Creating a interactive virtual workspace for the Design Team to achieve integrated design goals
- 3D Virtual functionality viewing and testing of the design
- 5D Model based material quantity take-offs & cost estimating
- Integrating information such as electronic specifications that are tied to the BIM
- Automated code checking
- Modular construction and off-site fabrication
- Repeatable modular construction components to speed erection time

5.16 California Community College Process

Where applicable, BIM modeling efforts shall comply with requirements of the California Education Code, Title 5 of the California Code of Regulations, the California Community Colleges Taxonomy of Programs Manual, Sixth Edition, and the State.

5.17 Agency

DSA currently does not require submittal of a Project BIM model. However, the CCSF supports the adoption of this practice as time progresses and technology advances. Submittal of BIM model for review and reference will be beneficial as it will improve the collaboration effort and expedite the plan review and approval process.

5.18 As-builts

The BIM model must be updated continuously throughout the construction phase and must document all built conditions, RFI's, etc. GC shall have modeler(s) on site continuously to update constructed changes accordingly. Design Team shall update design changes coordinated with the contractor via RFI's and change orders.

Upon substantial completion, the Design / Construction Teams must submit the As-built BIM to the CCSF. The as-built BIM shall include the following:

- All as-built information
- Native file formats and all associated and linked files (if applicable)
- All digital fabrication models generated by Contractor and Sub-contractors.

5.19 Closeout

CCSF shall be submitted to following closeout deliverables within 30 days of substantial completion:

- As-built model (.rvt format)
- 2D As-built documents (bound .dwg format)
- Electronic field set as-builts (.pdf format)
- O&M Manuals (hard copy and .pdf format)
- COBie construction worksheets (.xls format)
- Coordination models in native / authoring format
- FUSION Space Inventory Schedules (.xls format)

6 BIM Modeling Requirements

6.1 General & Model Ownership

In contributing content to the Model, the Model Element Author does not convey any ownership right in the content provided or in the software used to generate the content. Unless otherwise granted in a separate license, any subsequent Model Element Author's and Model User's right to use, or further transmit the Model is specifically limited to the design and construction of the Project, and nothing contained in this document conveys any other right to use the Model for another purpose.

- a. BIM shall be used for all building systems design, development, and analysis, including but not limited to architectural, structural, mechanical, electrical, plumbing, and fire suppression, etc.
- b. During SD and DD Phases, BIM technology shall be used to develop and establish building performance and the basis of design in accordance with CCSF Standards. The model shall be interoperable with analytic tools including but not limited to envelope, orientation, daylighting, energy consumption, building management system (BMS), building automation systems (BAS), renewable energy strategies, life cycle cost analysis, and spatial requirements.

Comment [ub3]: San Diego CCD language re Model ownership: "With the exception of matters or things that are subject to a patent or copyright issued by the U.S. Government, all building models that are prepared by prime designer, design consultant, prime contractor, trade contractor or supplier for use in connection with the project, shall be deemed the sole and exclusive property of the District, whether work is commenced or completed."

- c. Use BIM authoring software element libraries when creating model objects. Model objects shall contain parts and components as opposed to simple 3D Geometry (e.g. walls, doors, windows, railings, stairs, and furniture, etc.)
- d. Model objects shall contain IFC (Industry Foundation Class) parameters and associated data applicable to building systems requirements. These elements shall support the analytic process including size, material, location, mounting heights, and system information where applicable. As an example, a light fixture may contain several parameters such as energy output requirements, user illumination levels, make, model, manufacturer, and bulb life.
- e. Sustainable design principles and LEED credit documentation shall be included in the BIM to analyze, document, and verify project LEED goals (if within project scope)
- f. For DBB (Design-Bid-Build) projects, Design Team shall provide (via CCSF) awarded General Contractor a copy of the fully coordinated and assembled BIM (in Navisworks or equal as approved), as well as the Authoring BIMs for each trade. These authoring BIMs shall be used as basis of fabrication models generated by subcontractors. It is recommended that Design Team and Contractor establish a protocol for digital data exchange (i.e. interoperable file formats) prior to providing these models.
- g. The Contractor shall utilize model geometry and extract graphical information for generating construction administration documents from the Project BIM (RFI's, Directives, Bulletins, and Change Orders, etc.). The Contractor shall record as-built conditions in BIM as part of final delivery to BIM.
- h. DSA submittal drawings, calculations and analysis shall be extracted from the Project BIM.
- i. Elements, objects and equipment shall be tagged with unique identifiers (GUIDs).

6.2 Types of Model Elements

BIM Model elements shall be derived from the following sources:

- a. **Manufacturer`s Model Elements:** These elements that are created by and acquired from manufacturers often have more information than is prudent to keep in the BIM model; appropriate level of detail should be retained for the design element. However, embedded performance data shall remain for analysis and specification purposes.
- b. **Custom Created Model Elements:** These custom created elements must utilize appropriate BIM Authoring tool templates to create custom elements. Custom models components need to be assigned as a part and part of a family or group.
- c. **District Provided Model Elements (District Standards):** These are created by district appointed specialists, containing the minimum standards set forth in this document.

6.3 Model-based Quantity Take-off & Specifications

The Design Team shall extract square foot and system information using BIM Authoring Software and other BIM integrated tools to support comparative costs analysis of options studied. Outputs shall be converted to spreadsheets and submitted as part of the deliverable at end of the design development phase.

Comment [f4]: Though CAD-based QTO is common these days, LACCD is not requiring model based quantity take offs (QTO) at this time. They say that they will address this requirement in later versions of this Standard as technology progresses. Otherwise Innovaya or equal would be the software to reference. Same applies to Model-based specifications.

6.4 Model Geographic Location

The spatial coordinates of the master BIM file shall be set at the beginning of the project. Once established, spatial coordinates shall only be changed by mutual consent of the team and the CCSF project manager, with the matter recorded in the meeting minutes and the BEP. Once the design coordinate system is agreed upon, any model(s) of existing buildings relevant to the project shall be converted into the coordinate system used of each designed building.

The CCSF requires that a building within a BIM file shall include a geo-reference to accurately locate that building within the site and to give it a physical location context at larger scales. The BIM Manager shall geo-reference site plans and building models for site layout surveying and future GIS use in accordance with the State Plane Coordinate system where the project is located. The BIM file point shall be located at the SW corner of the structural grid (The USGS Reference will always read as 0.0.0 – the project base pint will read whatever the distance is from the USGS Reference to the lowest left hand point of the building structural grid).

6.5 Requirements for Modeling Space

- a. Space information imported from Fusion or the Onuma Planning System (OPS) in .xls. format shall be the source for space creation in BIM. Other sources are program narrative, CCSF Design Guides, and other directives as applicable.
- b. Spatial data should be generated and associated with bounding elements (walls, doors, windows, floors, ceilings)
- c. Space/area schedules and diagrams must be dynamically updated from the model geometry.
- d. CCSF spatial requirements must be validated using BIM.

6.6 Space Naming and Coding

Each space (area of four square feet or greater) shall include the following attributes throughout the Design and Construction BIM models:

- **Building**
- **Wing**
- **Floor**
- **Department / sub-department**
- **Space name** (English name and Abbreviation)
- **Room number(s)** (if CCSF way finding room no. and construction document number are different)
- **Space code** (CCSF Room Code)
- **Unique space number** (GUID – Globally Unique Identifier automatically assigned by BIM software and preserved through generation and regeneration of IFC deliverables)
- **Space type** (OmniClass)
- **Space measurement** (Net Square Footage (NSF), Department Net Square Footage (DNSF), Department Gross Square Footage (DGSF), and Building Gross Square Footage (BGSF))

6.7 Mechanical and other Equipment Coding

Each individual piece of special equipment (educational or other) and building mechanical equipment shall include the following attributes and be maintained throughout the Design and Construction BIM models:

- **Item name** (English name and Abbreviation)
- **Item code**
- **Unique item number** (GUID – Globally Unique Identifier automatically assigned by BIM software and preserved through generation and regeneration of IFC deliverables)
- **Item type** (OmniClass)
- **Item tracking number**
- **Other data available from FUSION or Onuma Planning System (OPS)** that is accommodated by the COBie spreadsheet and is appropriate to the LOD for the submission phase

6.8 Final BIM Deliverables

It is CCSF's intention to use the BIM model for Facilities Operations and Management upon occupancy. Information that matures during the construction process is to be captured in the appropriate models on an on-going basis throughout the construction phase. The use of these models is a developing methodology, and presently, multiple formats of information are required.

Upon Substantial Completion, BIM files shall be summated to the CCSF, and shall be clean of extraneous "scrap" or "working space" layers, stories, abandoned designs, object creation and testing places, empty layers, and other content which is typically produced in BIM production. Unless the project acquisition strategy realigns these responsibilities, CCSF shall receive the following as final BIM deliverables:

3D Geometric Deliverables – Construction Coordination Model

The Contractor shall be responsible for providing CCSF consolidated as-built Model(s) for building systems. The Model(s) shall be fully coordinated and align with the Design Model for architecture and structure; the required instructions on file/folder setup shall also be included:

1. Contractor – Native file formats of the final consolidated as-built Model(s) for building systems used in the multi-discipline coordination process (version as agreed in BIM Execution Plan)
2. Contractor – IFC file format of the consolidated building systems models (version as agreed in BIM Execution Plan)

3D Geometric Deliverables – Design Intent Model

The Design Team is to ensure that the "Design Intent model" remains current with all approved bulletins for overall scope. It is not expected that product specific information will be added to this model. Provide the Model information for architecture and structure and the required instructions on file/folder setup:

1. Design Team – Native file format(s) of Design Model (version as agreed in BIM Execution Plan)
2. Design Team – IFC file format (version as agreed in BIM Execution Plan)

Data Deliverables

1. Contractor – Provide COBIE database file containing room and product data information described in previous sections of this document.
2. Design Team – Provide room/space data in COBIE format to be included in Contractor COBIE database.

2D Deliverables

1. Contractor – Provide As-built drawings in PDF format with fully bookmarked pages.
2. Design Team – Provide one printed set of final documents generated from the Design Intent model in a) PDF format with fully bookmarked pages b) DWG format (latest current version) with bound views to each sheet.

Digital Deliverables

All digital deliverables are to be submitted on DVD/CD with the data clearly organized and software version(s) labeled.

6.9 Modeling Standards

6.9.1 General Requirements

BIM models shall be dimensionally accurate. Details and components that are not represented in the BIM model must be obtained from the 2D drawings. In BIM, components that are not dimensionally located per the construction documents shall show the true representation of actual as-built condition, and all dimensions are to be computer generated. Measurement accuracy must be 1/64".

Comment [f5]: CCSF graphic standards for drawing production shall apply, if available (SDCCC and LACCD has these). Otherwise the U.S. National CAD Standards (NCS) shall apply.

6.9.2 Site, Civil and Terrain Models

As described in Section 5.3 of this document, modeling of the project site and the existing structures shall be part of the BIM requirements for new and renovation projects. Modeling of existing buildings shall be performed based on CCSF provided as-built information, with field verification or electronic measurements conducted by Project team to validate the level of accuracy.

Proposed site conditions shall reference campus benchmarks, and reference existing surveys and GIS mapping systems for accuracy. New site and utility conditions shall be modeled in 3D, and shall coordinate system and spatial models three dimensionally. Where other system are directly impacted by landscape features such as vegetation, irrigation those elements shall be modeled with correct size and clearance requirements in BIM.

The Civil discipline deliverable model shall be developed to include systems as defined by the BIM Standards. BIM authoring software shall be used to model parametric components and objects not provided by the District. Model objects shall contain parameters and associated data applicable to the building system. The level of detail shall evolve as established by the model progression specification, but at minimum must include all features that would be included on a 1"=20" scale drawing.

BIM terrain model shall show actual site conditions and proposed grading, vertical elevation changes at walls, and building pads for use in joining 3D utility and building models into a common vertical and horizontal datum. The elevations in the 3D surface model shall be based on available topography received from record drawings or survey.

The surface will show detailed features such as existing walkways, roads, curbs, ramps, parking lot striping, sportive fields (with striping), and site walls with detailed elevation information for each feature. These components should be modeled to produce grading plans and site sections.

6.9.3 Utility Model

All existing and new/proposed utilities to point-of-connection and within project boundary to 5 feet of the building footprint shall be incorporated in a BIM model, including fire hydrants, fire department connections (FDC) and backflow preventers. The modeled utility pipe systems must contain the following database information to produce accurate plans and details for the project site:

- **Material type**
- **Size**
- **Slope**
- **Elevation**
- **Year installed**

CCSF will pothole the following utilities for accurate depth whenever this information for existing utilities are missing or unknown:

- **Storm Water**
- **Sanitary Sewer**
- **Domestic Potable Water**
- **Fire Service Water**
- **Irrigation Main(s)**
- **Cold/Hot water Return and Supply**
- **Gas**
- **Electrical**
- **Communications**

6.9.4 Architectural Models

If available, the District's Revit template shall be incorporated as part of the BIM model. The deliverable model shall include the systems as defined by the BIM Standards. Parametric components not provided by the District shall be modeled by the BIM authoring software. The level of detail shall evolve as established by the model progression specification, but at minimum must include all features to accurately represent the design solution. The building systems models shall be linked into the architectural model and be displayed when producing SD, DD and CD documents.

Modeling of existing structures shall be included in the BIM requirements for new construction and renovation projects. If available and depending on the project, a model may be obtained from CDCC. For all projects, the modeling of existing buildings and structures shall be based on District-provided as-built information, with field verification conducted by the project team to validate the level of accuracy.

Model components shall contain parameters and associated data applicable to the building systems, including: Phase Created, Dimensions, Model,

Manufacturer, Assembly Code – UniFormat Code, Specification Number, OmniClass Number and OmniClass Title. The object attribute information that is entered in during design will be used throughout the building lifecycle and integrated into the final as-built database.

Minimum Architectural Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- Architectural Site Plan: Site amenities and other architectural elements typically included on enlarged scale site plans
- Rooms / Spaces: Room names and numbers, accurate net square footage, finish properties, programmatic information and space inventory information
- Walls and Curtain Walls: Interior and exterior walls shall be modeled to exact height, length, width, finish and rating (thermal, acoustic and fire) to properly reflect wall types. Curtain wall systems to have mullions and window panes according to their true profile.
- Doors, Windows and Louvers: These shall be modeled to represent actual size, type and location, both interior and exterior.
- Ceilings: Ceiling system, soffits, openings, slopes and accessories
- Roof: The Model shall include the roof with overall thickness including insulation, drainage system, major penetrations, access ladders and other specialties.
- Vertical Circulation: Elevator, escalator, stairs, handrails and guardrails
- Architectural Specialties and Casework: All architectural specialties including toilet partitions, grab bars, lockers, display case, shelving and other interior architectural elements. Casework shall be modeled and include dimensions, WI number and additional information as defined for model components.
- Fixtures and Equipment: They should be modeled to meet layout requirements.
- Schedules: Door, window and finish schedules shall be provided and information must be extracted from the model components.
- Signage: All signage components should be modeled.

6.9.5 Building Systems Models

System models shall be developed as separate BIM models on a floor-by-floor basis. Deliverables shall be developed to include systems as defined by this document, CCSF BIM Standards. Modeled objects shall contain parameters and associated data applicable to the building system. The level of detail shall evolve per the model progression specification. System models are required for structural, mechanical, electrical/telecommunication/security, plumbing and fire protection.

Model components shall contain parameters and associated data applicable to the building systems, including: Phase Created, Dimensions, Model, Manufacturer, Assembly Code – UniFormat Code, Specification Number, OmniClass Number and OmniClass Title. Light fixture components shall include lamp type and photometric information including light loss factor, initial intensity,

initial color and color filter. The object attribute information that is entered in during design will be used throughout the building lifecycle and integrated into the final as-built database.

Minimum Structural Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- Foundations: All foundation and footing elements should be modeled
- Floor Slabs: Structural floor slabs including recesses, curbs, pads and major penetrations.
- Structural Steel Framing and Decking: All steel framing including columns, primary and secondary framing members, bracing, roof deck and floor deck.
- Cast-in-Place Concrete: All retaining walls, columns and beams
- Pre-cast Concrete: All primary and secondary elements
- Expansion Joints: Joints shall be accurately depicted
- Stairs: Stair framing members and necessary openings for stair system
- Shafts and Pits: All shafts, pits and openings

Minimum Mechanical Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- HVAC Equipment: Air handling units (AHU), Fans, VAV boxes, compressors, cooling towers, chillers, air handlers, heat pumps, boilers, hoods and other major equipment
- HVAC Distribution: Air distribution ducts for supply, return, ventilation and exhaust ducts, duct hangers, seismic bracing, fire smoke dampers, control systems, registers, diffusers, grills and louvers. Ducting to be modeled to outside face dimension.
- Mechanical Piping: All piping $\frac{3}{4}$ " diameter and greater shall be modeled to outside diameter of pipe or pipe insulation, whichever is greater.
- Equipment clearances: Clearances shall be modeled for use in clash detection process and maintenance access requirements.

Minimum Plumbing Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- Fixtures and Equipment: All plumbing fixtures, sinks, toilets, floor and roof drains, leaders, sumps, booster pumps, grease interceptors, sediment separators and other major equipment.
- Piping: All piping to five feet outside building footprint, including hot and cold water piping, sewer piping, storm drain piping, gas piping, pipe hangers, seismic bracing, cleanouts and valves. Piping shall be modeled to outside diameter of pipe or pipe insulation, whichever is greater.

- Equipment clearances: Clearances shall be modeled for use in clash detection process and maintenance access requirements.

Minimum Electrical/Telecommunications/Security Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- Power: Transformers, emergency generators, main and distribution panels, switchgear, outlets, switches and junction boxes. Electrical feeders and conduits larger than ¾" shall be modeled, including underground.
- Lighting: Permanently mounted light fixtures, lighting controls, switches and junction boxes.
- Communications: All existing and new communications service controls, audio equipment, speakers, phone and data ports and connections, both above ground and underground. Cable tray routing with hanger supports and seismic bracing. Communications conduit ¾" and greater shall be modeled.
- Security: all security devices, keypads, cameras and motion sensors.
- Equipment clearances: Clearances shall be modeled for use in clash detection process and maintenance access requirements.

Minimum Fire Protection Model Requirements

Model shall be documented in the BIM Authoring software. Parametric links shall be maintained within the model to enable automatic generation of all plans, sections, elevations and schedules.

- Fire Protection System: All fire protection components including main lines, branch piping, sprinkler heads, valves, drains, pumps, tanks, sensors, heat and smoke detectors, notification devices, control panels, fire annunciation panels and related equipment.

6.9.6 Technology Platform & Software Interoperability

CCSF shall accept true 3D solid modeling, object oriented software applications that comply with current industry interoperability standards and are able to be used in a collaborative environment. All software platforms used for CCSF shall be compliant with:

- The most current version of Industry Foundation Classes (IFC) file format
- Commercially available collaboration software that provides interoperability between the different software applications (see next page)
- Software other than those listed in next page may be used subject to the above compliance requirements and approval by CCSF Staff.
- Traditional 2D documentation shall be prepared with approved IFC compliant BIM authoring software and plans, elevations, sections, schedules, and details shall be derived and fully coordinated with the coordinated building model. All other documents shall be submitted per the CCSF contract documents.

Software Type	Available
Planning/ Preliminary Cost Estimates	Onuma Planning System (OPS), DProfiler, Tokmo, CodeBook
Authoring – Design (Architecture, Structural)	Revit Architecture, Bentley BIM, ArchiCAD, Tekla or equal
Authoring – MEP-F (Engineering & Construction)	Revit MEP, ArchiCAD MEP, AutoCAD MEP, Bentley BIM, CAD-Duct, CAD-Pipe, AutoSprink, PipeDesigner #D or equal
Authoring – Civil	Autodesk Civil 3D, Bentley Inroads & Geopak
Coordination (spatial conflict, clash detection)	Horizontal Glue , Navisworks Manage, Bentley Navigator & Solibri Model Checker
4D Scheduling	Synchro, Vico, Navisworks Simulate, Primavera, MS Project & Bentley Navigator
5D Cost Estimate	Innovaya, Vico or equal
Energy Analysis	EcoDesigner, Ecotect, eQuest, Green Building Studio, IES, Hevacomp, TAS or equal
Model Checking Validation, IFC File Optimizer	Solibri or equal
COBie	EcoDomus/Tokmo COBie Exchange, Onuma Systems
Water Management	Bentley WaterGem

6.9.7 Model Progression Specification (MPS) & Level of Development (LOD)

To facilitate BIM development, the design and construction teams shall follow the Model Progression Specification and Level of Detail (LOD) definitions as CCSF adapted from AIA. Project Teams should also refer to the Object Element Matrix developed by VA (Veterans Administrations), that defines object and element properties and attributes by UniFormat / OmniClass classification.

Model Progression Specification for BIM

Model Progression Specification (MPS) addresses the need for a framework for defining a BIM's precision and suitability for specific uses during various stages of the model development. This approach was adopted by AIA and incorporated it into the new E202, an exhibit which formalizes the processes for development and use of BIM's for a specific project, to aid teams in agreeing on the purposes for which the project BIM(s) will be used, the level of detail to which specific elements of the BIM(s) will be brought at the conclusion of each phase, and who will develop specific elements of the BIM(s) to the specific levels of detail.

Level of Detail (LOD)

The core of the MPS is the Level of Development (LOD) definitions—descriptions of the steps through which a BIM element can logically progress from the lowest level of conceptual approximation (LOD Level 100 - conceptual) to the highest level of representational precision (LOD Level 500 – as-built), identifying the specific content requirements for each model element at each phase of a project. There are (5) five progressively detailed levels of completeness and each subsequent level builds on the previous level. Following LOD's shall be used to complete the model element table required at each phase of a project:

1. LOD 100: This is the “programming” level. Buildings and/or structures shall be modeled as overall masses indicative of area, height, volume, spatial location, and orientation. The model at this level of detail may be analyzed based on volume, area and orientation by application of performance analysis software. The model may be used to develop conceptual cost estimate, preliminary energy modeling project scheduling, project phasing and overall duration for master-level planning purposes.
2. LOD 200: This is the “planning” level. Buildings and/or structures including major architectural, structural, mechanical, electrical, and plumbing objects shall be modeled as generalized systems or assemblies with approximate quantities, approximate configuration, spatial location, and orientation. Non-geometric information shall be attached to the model elements. The model at this level may be analyzed for performance of selected systems by application of performance analysis software. The model may used to show sequenced, time-scaled appearance of major elements and systems.
3. LOD 300: This is the “design” level. Buildings and/or structures including all objects shall be modeled as specific systems or assemblies with accurate quantities, recognizable configuration, spatial location, and orientation. Non-geometric information shall be attached to the model elements. The model at this level of detail is suitable for the generation of traditional construction documents and shop drawings. The model may be analyzed for performance and coordination of selected system by application of performance analysis and clash/interference detection software. The model may used to show sequenced, time-scaled appearance of detailed elements and systems.
4. LOD 400: This is the “construction” level. Buildings and/or structures including all objects shall be modeled as specific systems or assemblies with accurate quantities, recognizable configuration, spatial location, and orientation, with complete fabrication, assembly, and detailing information. Non-geometric information may be attached to the model elements. Model elements at this level of development are visual representations of the proposed element and are suitable for bidding and construction. The model may be analyzed for performance and coordination of selected system by application of performance analysis and clash/interference detection software. The model may be used to show sequenced, time-scaled appearance of detailed specific elements and systems including construction means and methods.
5. LOD 500: This is the “as-built” level. Buildings and/or structures including all objects will be modeled as constructed systems or assemblies with accurate quantities, shape, spatial location, and orientation, with complete fabrication, assembly, and detailing information. Non-geometric information may be attached to the model elements. The model may be utilized for maintenance, operation, renovation and addition or new construction purposes after completion of the building construction.

Model Progression Specification

There is a significant amount of information that can be linked to an element in a BIM, and this information may be provided by a variety of individuals involved in a project. The model progression specification identifies the LOD required for each model element at the end of each project phase and the model element author (MEA) who is responsible for creating and developing the model element, its 3-dimensional representation of the component, but not necessarily for other discipline-specific information linked to it. CCSF expects that each project team will validate and adjust the contents to align with the scope of the project and the capabilities of the project team.

Abbreviations for each MEA to be used and Phases are as in the following:

PD Prime Designer
DC Design Consultant
PC Prime (General) Contractor
TC Trade Contractor
S Supplier
SD Schematic Design
DD Design Development
CD Construction Documents
CON Construction
FOM Facilities Operation & Management

Example of Model Element Table, adapted from AIA E202 - 2008

Model Elements (CSI UniFormat II Classification)					Project Phase, Level of Detail (LOD) & Model Element Author (MEA)														
					Schematic Design (SD)		Design Development (DD)		Construction Documents (CD)		Construction (CON)		Facilities Operation & Management (FOM)						
					LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA					
A	SUBSTRUCTURE	A10	Foundations	A1010	Standard Foundations	100	PD	200	DC	300	TC	400	TC	500	TC				
				A1020	Special Foundations	100	PD	100	DC	300	TC	400	TC	500	TC				
				A1030	Slab on Grade	100	PD	200	DC	300	TC	400	TC	500	TC				
		A20	Basement Construction	A2010	Basement Excavation	100	PD	200	DC	300	TC	300	TC	500	TC				
				A2020	Basement Walls	100	PD	200	DC	300	TC	400	TC	500	TC				
B	SHELL	B10	Superstructure	B1010	Floor Construction	100	PD	200	PD	300	PD	300	PC	500	PC				
				B1020	Roof Construction	100	PD	200	PD	300	PD	300	PC	500	PC				
		B20	Exterior Enclosure	B2010	Exterior Walls	100	PD	200	PD	300	TC	400	TC	500	TC				
				B2020	Exterior Windows	100	PD	200	PD	300	TC	400	TC	500	TC				
				B2030	Exterior Doors	100	PD	200	PD	300	TC	400	TC	500	TC				
		B30	Roofing	B3010	Roof Coverings	100	PD	200	PD	300	TC	300	TC	500	TC				
B3020	Roof Openings			100	PD	200	PD	300	TC	300	TC	500	TC						
C	INTERIORS	C10	Interior Construction	C1010	Partitions	100	PD	200	PD	300	PD	400	TC	500	TC				
				C1020	Interior Doors	100	PD	200	PD	300	PD	400	TC	500	TC				
				C1030	Fittings	100	PD	100	PD	300	PD	400	TC	500	TC				
				C20	Stairs	C2010	Stair Construction	100	PD	200	PD	300	TC	400	TC	500	TC		
				C2020	Stair Finishes	100	PD	100	PD	100	TC	100	TC	100	TC				
		C30	Interior Finishes	C3010	Wall Finishes	100	PD	100	PD	100	PD	100	TC	100	TC				
				C3020	Floor Finishes	100	PD	100	PD	100	PD	100	TC	100	TC				
				C3030	Ceiling Finishes	100	PD	100	PD	100	PD	100	TC	100	TC				
				D	SERVICES	D10	Conveying	D1010	Elevators & Lifts	100	PD	200	PD	300	DC	400	TC	500	TC
								D1020	Escalators & Moving Walks	100	PD	200	PD	300	DC	400	TC	500	TC
D1030	Other Conveying Systems	100	PD					200	PD	300	DC	400	TC	500	TC				
D20	Plumbing	D2010	Plumbing Fixtures					100	PD	100	DC	300	TC	400	TC	500	TC		
		D2020	Domestic Water Distribution					100	PD	100	DC	300	TC	400	TC	500	TC		
		D2030	Sanitary Waste			100	PD	100	DC	300	TC	400	TC	500	TC				
		D2040	Rain Water Drainage			100	PD	100	DC	300	TC	400	TC	500	TC				
		D2090	Other Plumbing Systems			100	PD	100	DC	300	TC	400	TC	500	TC				
D30	HVAC	D3010	Energy Supply			100	PD	100	DC	300	TC	400	TC	500	TC				
		D3020	Heat Generating Systems			100	PD	200	DC	300	TC	400	TC	500	TC				
		D3030	Cooling Generating Systems	100	PD	200	DC	300	TC	400	TC	500	TC						
		D3040	Distribution Systems	100	PD	100	DC	300	TC	400	TC	500	TC						
		D3050	Terminal & Package Units	100	PD	100	DC	300	TC	400	TC	500	TC						
		D3060	Controls & Instrumentation	100	PD	100	DC	100	TC	100	TC	100	TC						
		D3070	Systems Testing & Balancing	100	PD	100	DC	100	TC	100	TC	100	TC						
		D3090	Other HVAC Systems & Equipment	100	PD	100	DC	300	TC	400	TC	500	TC						
		D40	Fire Protection	D4010	Sprinklers	100	PD	100	DC	300	TC	400	TC	500	TC				
				D4020	Standpipes	100	PD	100	DC	300	TC	400	TC	500	TC				
D4030	Fire Protection Specialties			100	PD	100	DC	300	TC	400	TC	500	TC						
D4090	Other Fire Protection Systems			100	PD	100	DC	300	TC	400	TC	500	TC						
D50	Electrical			D5010	Electrical Service & Distribution	100	PD	100	DC	300	TC	400	TC	500	TC				
		D5020	Lighting and Branch Wiring * (Common current practice is to model lighting fixtures for coordination purposes, but not to model branch wiring.)	100	PD	100	DC	300/100*	TC	400/100*	TC	500/100*	TC						
		D5030	Communications & Security	100	PD	100	DC	100	TC	100	TC	100	TC						
		D5090	Other Electrical Systems	100	PD	100	DC	100	TC	100	TC	100	TC						

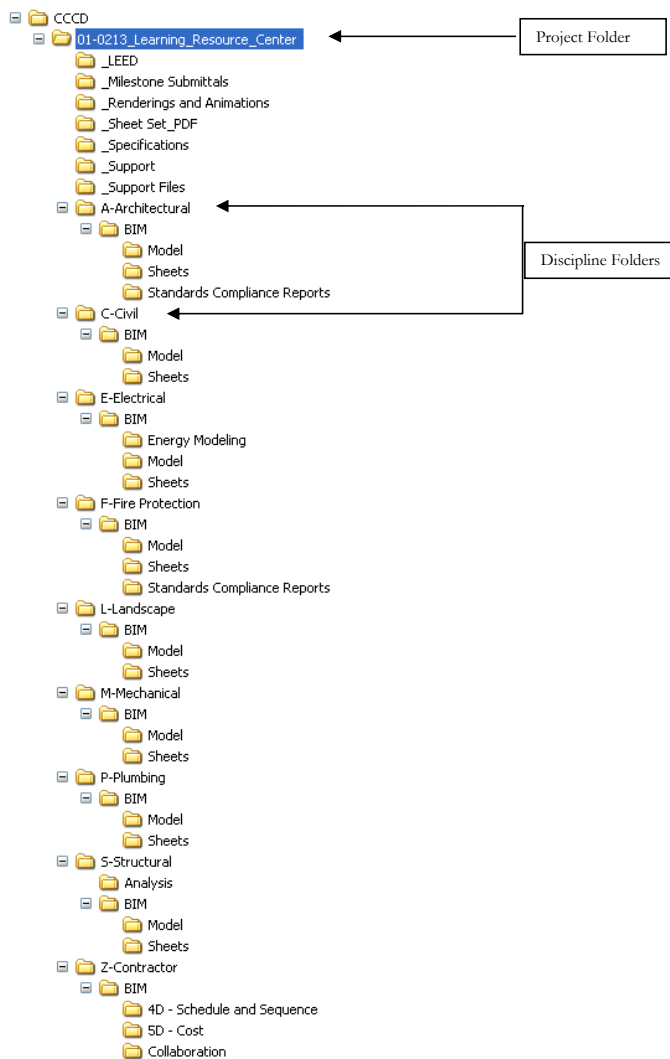
Model Elements (CSI UniFormat II Classification)					Project Phase, Level of Detail (LOD) & Model Element Author (MEA)														
					Schematic		Design		Construction		Construction		Facilities						
					LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA					
E	EQUIPMENT & FURNISHINGS	E10	Equipment	E1010	Commercial Equipment	100	PD	100	PD	300	TC	400	TC	500	TC				
				E1020	Institutional Equipment	100	PD	100	PD	300	TC	400	TC	500	TC				
				E1030	Vehicular Equipment	100	PD	100	PD	300	TC	400	TC	500	TC				
				E20	Furnishings	E1090	Other Equipment	100	PD	100	PD	300	TC	400	TC	500	TC		
						E2010	Fixed Furnishings	100	PD	100	PD	300	PD	400	PD	500	PD		
						E2020	Movable Furnishings	100	PD	100	PD	100	PD	100	PD	100	PD		
F	SPECIAL CONST. & DEMO	F10	Special Construction	F1010	Special Structures	100	PD	200	PD	300	PD	400	PD	500	PD				
						F1020	Integrated Construction	100	PD	100	PD	300	PD	400	PD	500	PD		
						F1030	Special Construction Systems	100	PD	100	PD	300	PD	400	PD	500	PD		
						F1040	Special Facilities	100	PD	100	PD	300	PD	400	PD	500	PD		
								F1050	Special Controls & Instrumentation	100	PD	100	PD	100	PD	100	PD	100	PD
						F20	Selective Bldg Demo	F2010	Building Elements Demolition	100	PD	200	PD	300	PD	400	TC	500	TC
		F2020	Hazardous Components Abatement	100	PD			100	PD	100	PD	100	TC	100	TC				
G	BUILDING SITEWORK	G10	Site Preparation	G1010	Site Clearing	100	PD	100	PD	100	PD	100	TC	100	TC				
						G1020	Site Demolition & Relocations	100	PD	200	PD	300	PD	300	TC	300	TC		
						G1030	Site Earthwork	100	PD	200	PD	300	PD	300	TC	300	TC		
						G1040	Hazardous Waste Remediation	100	PD	100	PD	100	PD	100	TC	100	TC		
						G20	Site Improvements	G2010	Roadways	100	PD	200	PD	300	PD	300	TC	300	TC
								G2020	Parking Lots	100	PD	100	PD	300	PD	300	TC	300	TC
				G2030	Pedestrian Paving			100	PD	100	PD	300	PD	300	TC	300	TC		
						G2040	Site Development	100	PD	100	PD	300	PD	300	TC	300	TC		
						G2050	Landscaping	100	PD	100	PD	300	PD	300	TC	300	TC		
				G30	Site Civil/Mech Utilities	G3010	Water Supply & Distribution System	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3020	Sanitary Sewer Systems	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3030	Storm Sewer Systems	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3040	Heating Distribution	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3050	Cooling Distribution	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3060	Fuel Distribution	100	PD	100	DC	300	TC	400	TC	500	TC		
						G3090	Other Civil/Mechanical Utilities	100	PD	100	DC	300	TC	400	TC	500	TC		
				G40	Site Electrical Utilities	G4010	Electrical Distribution	100	PD	100	DC	300	TC	400	TC	500	TC		
						G4020	Site Lighting	100	PD	100	DC	300	TC	400	TC	500	TC		
		G4030	Site Communications & Security			100	PD	100	DC	300	TC	400	TC	500	TC				
		G4090	Other Electrical Utilities			100	PD	100	DC	300	TC	400	TC	500	TC				
		G50	Other Site Construction	G5010	Service Tunnels	100	PD	100	DC	300	TC	400	TC	500	TC				
				G5090	Other Site Systems & Equipment	100	PD	100	DC	300	TC	400	TC	500	TC				

7 Files, Security & Achieving

7.1 Project Folder Structure

It is critical to maintain a consistent file naming and structure for referenced (linked) files to function across Design and Construction Teams and for end users such as facilities operators and managers to retrieve files quickly once the project is complete. For this reason, City College of San Francisco has developed a filing protocol for the team when the BEPs are developed.

Sample Folder Type



The root location (drive letter) of the Project folders may differ between offices. However, all CCSF project data should be independent of the root drive letter in order to allow sharing between differing office server structures. The Root project Directory (CCSF) must reside directly below the Drive letter.

a. Campus Codes

CCSF currently has one campus and "01" as Campus code and shall be used with the Project Number, to be placed directly below the "CCSF" folder.

b. Project Number

Prior to work start, project teams shall be assigned a CCSF Project Number by the District's Project Manager. This number shall be used for organizing the project files, and should include the common name on the file name project. (Example: City College of San Francisco assigns the LRC (Learning Resource Center) project a project number of 0213. Therefore project folder shall be named 01-0213_Learning_Resource_Center)

c. Discipline Folders

Each discipline shall be assigned a folder corresponding to a Discipline Designator as listed in below table. All project files received and referenced from each discipline shall be organized in this folder. As a project progresses, the contents within these discipline folders will expand, and each deliverable should be clearly organized in its own folder.

Discipline Designations	
Discipline (in alphabetical order)	Designator
Architectural	A
Geotechnical	B
Civil	C
Process	D
Electrical	E
Fire Protection	F
General	G
Hazardous Material	H
Interiors	I
Landscape	L
Mechanical	M
Facilities / Operations	O
Plumbing	P
Equipment / Specialty Design	Q
Structural	S
Telecommunication	T
Security	TY
Survey	V
Civil Works	W
Other Disciplines	X
Contractor / Shop Drawings	Z

d. BIM Folder

BIM Files shall be sorted by model files and sheet files.

- **Model Files** - Original files from other disciplines should be linked from their discipline folder location and relative path to models. Model file names shall follow file naming convention in the BEP.
- **Sheet Files** – PDF and native file formats of the most current sheets shall be maintained in this folder and organized with sheet file naming outlined in File Naming Section of the U.S. CAD Standards (NCS)

e. Support Files

Standard items needed for the project, such as project specific symbols, applications (lisp, script, etc.), logos and graphics. Project Specific Model Content can also be placed here.

f. Coordination Files

Files for Construction coordination (clash detection) shall be managed by the BIM Manager, and organized by date as the project progresses.

g. Other Folders

Renderings, analyses, LEED, etc. will have their own folders which will be populated as the project progresses.

7.2 Variant Folder Tree

For projects that require multiple buildings, create building folders below the discipline directories.

7.3 Data Security

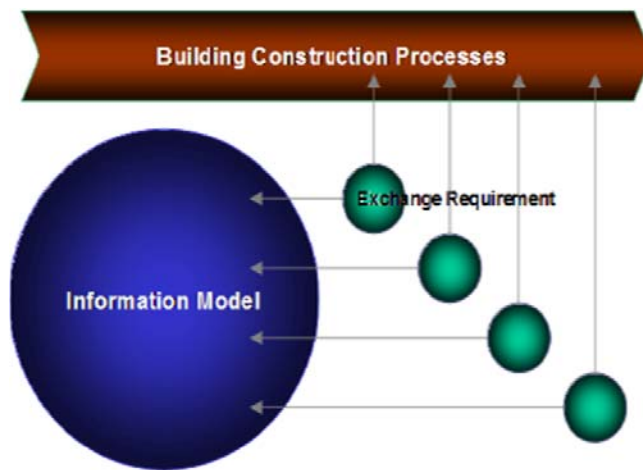
Project Teams (Design / Construction) shall establish a data security protocol to prevent any possible data corruption, virus “infections” and data misuse or deliberate damage by their own employees or outside sources. Both teams shall establish adequate user access rights to prevent data loss or damage during file exchange, maintenance and archiving.

7.4 Archiving Milestone Submittals

All documentation pertaining to Milestone Submittals shall be archived and stored within the project file structure with a heading corresponding to the submittal; for instance “100% Construction Documents” with its related sub-folders (“_LEED”, “_Renderings and Animations”, “_Sheet Set_PDF”, “_Specifications” and “_Support”.

8 Information Delivery Manual (IDM)

To use BIM effectively and for benefits to be unlocked, the quality of communication between different participants in the construction process needs significant improvement. If the information required is available when it is needed and the quality of information is satisfactory, the construction process will itself be significantly improved. For this to happen, there must be a common understanding of the building processes and of the information that is needed for and results from their execution.

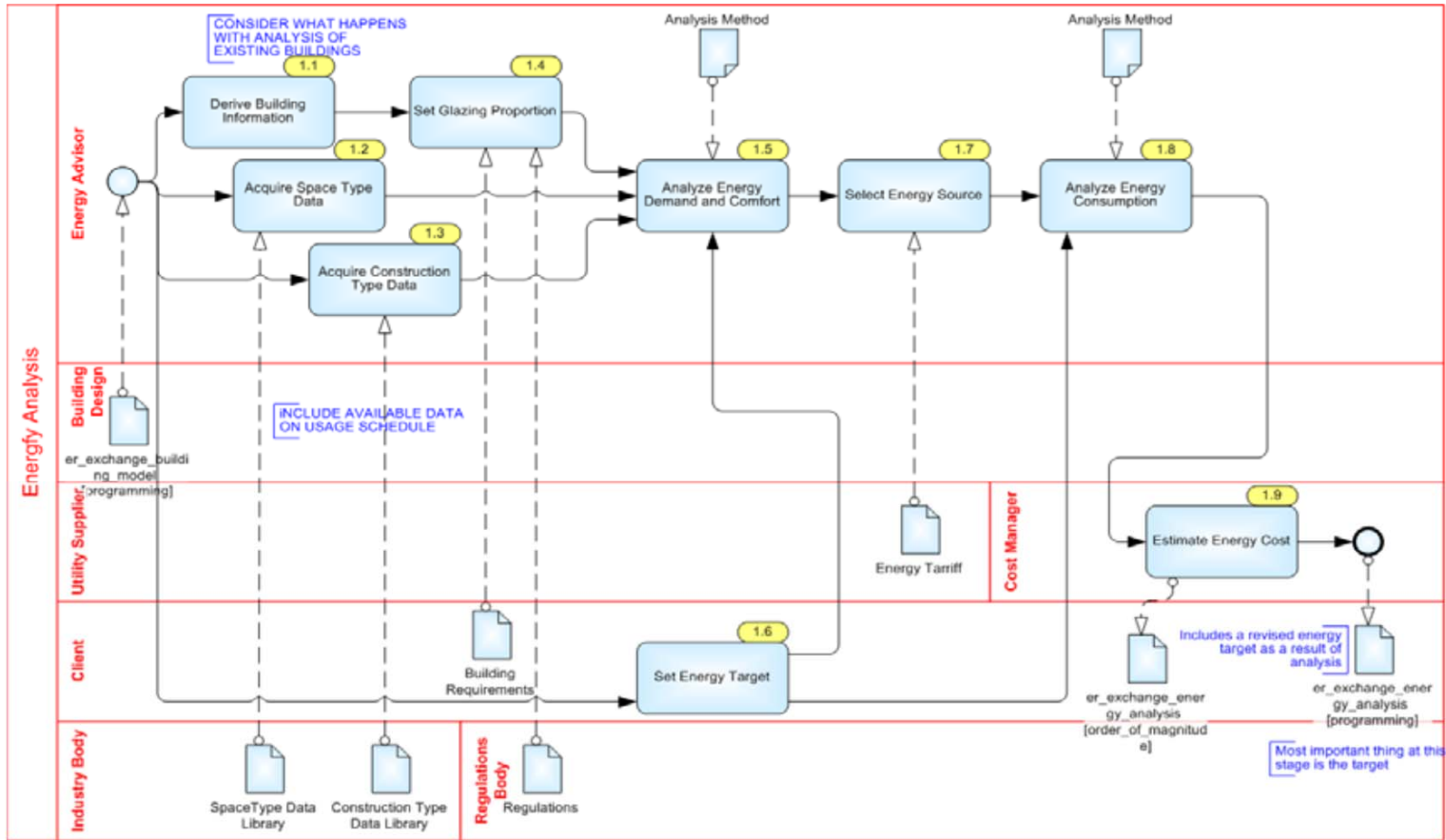


(Source: http://www.iai.no/idm/idm_resources/idm_methods_guides/IDMC_004_1_2.pdf)

IDM is a methodology to document the exchange of information using BIM tools to support the sustainable building design solutions with a process map that can be reused to support future project design. IDM captures (and progressively integrates) business process whilst at the same time providing detailed specifications of the information that a user fulfilling a particular role would need to provide at a particular point within a project.

CCSF requires Design Teams to provide IDMs for executing energy analysis, verification of geospatial requirements and other analysis (e.g. project water management and daylight harvesting) in compliance with the Information Delivery Model (IDM) published by the Building Smart Alliance (<http://idm.buildingsmart.no/confluence/display/IDM/Home>).

Next page is a sample IDM process map:



Energy Analysis		author: Jeffrey Wix	created: 05/01/2006 09:23:44	
Analyze Energy (Programming)		version: 1.2	modified: 11/02/2006 23:11:16	
		status: modified		
bpmn_energy_analysis.vsd				

Sample IDM Process Map
(Source: http://www.iai.no/idm/idm_resources/idm_methods_guides/IDMC_004_1_2.pdf)

9 Drawing Requirements for Paper (2D) Printing

9.1 General

BIM model(s) shall be utilized to the fullest extent for the purposes of deriving 2D CAD information and assembling a printed set of plans. All BIM information shall be fully parametric so that all applicable information regarding fixtures and/or other building elements can be generated for the schedules. Where required by CCSF, editable text files shall be attached to the fixtures / elements to assist with calculations. The U.S. National CAD Standards (NCS) shall apply with the following exceptions:

9.2 Diffuser Symbols

Either graphical arrows or blank-off panels can be used to represent air flow direction for diffusers.

9.3 Font

Arial font typeface shall be used. Font sizes shall comply with NCS; however, the use of 3/32" type is allowed. 3/32" scale is allowed where large elevations or footplates would extend over more than one sheet, but 1/8" or larger scale information shall also be provided for those areas where detail cannot be discerned at the smaller scale.

9.4 Line Styles and Line Weights

The internal software BIM Line Styles defaults shall be used instead of the NCS linetype definitions. The Design / Engineer Team has the discretion and responsibility to edit the default line weight values of the BIM software so printed documents reflect the graphic intent of NCS.

9.5 MEP-F Details

Where generating 2D MEP-F details from the BIM model is difficult, tagged definitions of the object based elements shall be provided.

9.6 Room Naming Abbreviations

Room names on 2D drawing sheets shall be abbreviated for legibility.

9.7 Title blocks

The CCSF CAD Title Block (if available) and Information shall be adapted for BIM use by the Design Team.

9.8 Uniform Parameters for Objects

The Veteran Administration (VA)'s "Object Element Matrix" can be used to assure that all model object parameters follow a consistent naming convention and be a reflection of industry standards.

9.9 CCSF Standard Details

When available in the future CCSF Standard Details will be valid as to the information the details contain, and shall be used for information regarding material and constructability content. In lieu of pulling the source images directly into the model, Design Team shall generate this information within the BIM model allowing for object-based recognition.

9.10 Uniform Parameters for Objects

The Veteran Administration (VA)'s "Object Element Matrix" can be used to assure that all model object parameters follow a consistent naming convention and be a reflection of industry standards.

9.11 Casework / Millwork Finishes & Legend

Finishes shall be assigned to the properties of the pieces of casework that is inserted into the room area. Parameters are created and added to the casework properties for finish assignments. Finishes that are assigned to the piece of casework properties shall be formatted into a Casework / Millwork Schedule to be placed on the sheet. Only rooms that have casework or millwork inserted into them will be generated in the schedule.

Material finish code and product information shall be entered into the casework properties and identified in the schedule generated from the Finish Legend.

9.12 Doors

Similar to partition types, door types are to be created to accurately reflect each kind of door in regards to type, size and information. The 2D door symbol is a result of the view that is created from the BIM model. Because of this, 3D doors shall be used throughout the construction documents for 2D representations. Multiple doors require the room number with a "1", "2", etc.

All doors are to be communicated in construction documents by schedule. Door schedule parameters built within doors in the BIM model shall have: Door number, Door width, Door Height, Door Material, Type, Frame Material, Frame Type, Fire Rating, Hardware Code, Head/Sill and Jamb Detail Numbers and Remarks for links to "Remarks and Abbreviations" Legend.

9.13 Interior Partition Types

A different partition type is to be created for each type of wall used in the project with each layer constructed in 3D form. The following system is an example used to classify, organize and manage partition types within the BIM model. It's used to help project teams establish a naming convention for cataloging all partition types in BIM model.

Partition type code example (BIM Model Catalog Number):

"09P4107b" – 09 (Specification Category)
P (Detail Type Category)
4 (Nominal Size)
1 (Partition Category)
07 (Sequence Number)
b (Fire/Smoke Rating)

Partition type code legend (Character exemplifies to define other wall types):

SPECIFICATION CATEGORY

- 03 CONCRETE PARTITION
- 04 MASONRY PARTITION
- 09 METAL STUD PARTITION

DETAIL TYPE CATEGORY

- P PARTITIONS

NOMINAL SIZE

- 1 SIZE 1" CORE
- 2 SIZE 2" CORE
- 4 SIZE 4" CORE
- 6 SIZE 6" CORE
- 8 SIZE 8" CORE

PARTITION CATEGORY

- 1 PARTITIONS W/NO INSULATION
- 2 PARTITIONS W/ INSULATION
- 3 PARTITIONS W/ TILE
- 4 PARTITIONS W/ LEAD LINING
- 5 PARTITIONS W/ SECURITY MESH

The "Wall – Interior Partition" in the U.S. Veterans Administration (VA)'s Object Element Matrix defines the elements appropriate for each stage of the project development and shall be included as required. Partition information shall have the ability to be scheduled. Each partition type shall hold parameters containing descriptions of its components and its construction which is shown in the schedule.

Fire rating fill patterns are to be constructed within 3D wall type so that the partition's respective rating is shown through all scales and through all types of views (plans, sections, isometric/axonometric views, etc). The fill patterns shall be graphically represented.

9.14 Model Integrated Text

BIM General Notations & Sheet Notes: Any notation that will populate multiple sheets shall be put on views that allow duplication of the notations on multiple sheets. Element-based schedules shall be used for notation that is specific per sheet.

BIM Material Notation: Rather than using loose text, BIM software allows model objects to be linked from the object's parameters to an editable text file that holds specification data for Construction Document notation purpose. This notation has the ability to be shown by either numeric specification section or object description.

9.15 Room Finishes

Room finishes shall be assigned to the room areas through the room properties, with parameters defining finish assignments. Finishes assigned to the room properties shall be formatted into a Room Finish Schedule to be placed on a sheet.

9.16 Finish Legend

Material Codes in the Room Finish Schedule that were entered in the room properties are identified in a Finish Legend. Product Information entered into the established parameters to specify finishes. Finish codes and their description shall be associated with the room properties.

9.17 Room Numbering

Room numbers shall be assigned to the properties of each individual room. Room tag types can be modified throughout the course of the project so that the appropriate room number is visible on the (submitted) documents.

9.18 Wayfinding

The CCSF Wayfinding Number shall be scheduled data within room schedules as per the Signage / Message Schedule.

10 Glossary & Abbreviations

4D Building Information Model with the addition of time (virtual building model with scheduling)

5D Building Information Model with the addition of time and construction cost information.

AE, AEC, AECFM
Abbreviations for Architect/Engineer, Architect/Engineer/Contractor and Architect/Engineer/Contractor/Facility Manager.

As-Built Model
A Federated Model incorporating all construction phase modifications to a LOD 400 or better.

BIM Execution Plan (BEP)
Defines the BIM roles and responsibilities within the project team.

Building Information Model (BIM)
A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.

Building Information Modeling
The process and technology used to create the building information model.

BuildingSMART
An international membership organization with representation in North America, Europe, Asia and Australasia. It brings together architects, engineers, constructors, product manufacturers and facility managers, along with software vendors.

Bid Model
The term used to describe the Federated Model that is established by the City College of San Francisco as part of the Contract Documents and can be used for Bid and/or Negotiation purposes.

CAD
Abbreviation for Computer Aided Design. A geometric/symbol based computer drawing system that replicated hand drawing techniques.

CCSF (or City College of San Francisco)
Abbreviation for City College of San Francisco.

COBIE (or COBie)

The model and facility data for commission, operations, and maintenance of the project shall satisfy the Construction Operations Building Information Exchange (COBIE) requirements, and be submitted in compliance with the commissioning requirements. The data expected from BIM for facility handover shall conform to the following standards: CCSF Spatial Requirements (via Fusion / Onuma Planning System), Unifomat, OmniClass, Geospatial, NBIMS, COBIE, NCS, and IFC standards for building information. COBIE data in the form of the COBIE Excel Spreadsheet and related commissioning information shall be delivered electronically in formats suitable for integration into current and future CAFM systems.

Construction Team

Prime/General Contractor and all of the trade contractors, fabricators, and suppliers that provide construction services for a project.

Collaboration Model

The term to describe the Federated Model used during the trade coordination phase.

Design Team

The Design Team is considered to be the Architect and all of the consultants that provide design services for a project

Digital Data

Digital Data is defined as information, communications, drawings, or designs created or stored for the Project in digital form.

DSA

Division of State Architect

Facility Model

The term used to describe a 3D model that incorporates all major equipment and components that require service and maintenance.

Federated Model

The Federated Model combines different modeled elements or assemblies through the process of linking files from their native platforms, maintaining their native properties. It is a virtual representation of the entire Project developed to a specified LOD.

FF & E

Furniture, Fixtures and Equipment

GSA

General Services Administration

IAI

International Alliance for Interoperability software companies, building product manufacturers, information publishers, owners, designers, and builders – in AEC and other industries whose goal is to develop a universal standard for information sharing.

IDM

Information Delivery Manual provides an approach to providing an integrated reference for process and data required for BIM. It describes how to identify and describe processes undertaken within construction, the information required for their execution and the results. It also describes how the information can be further detailed to support solutions provided by building information system providers in a form that enables its reuse and how it can be configured to meet national, local and project needs.

Industry Foundation Class (IFC)

An object oriented file format with a data model developed by BuildingSMART (International Alliance for Interoperability-IAI) to facilitate interoperability among BIM tools, cost estimation systems, and other construction-related applications in a way that preserves ability to perform analysis on those objects as they move from one BIM system to another. IFC's are data elements that represents parts of buildings, or elements of the process, and contain the relevant information about those parts. IFC's are used by computer applications to assemble a computer-readable model of facility that contains all the information of the parts and their relationships to be shared among project participants. The project model constitutes an object-oriented database of the information shared among project participants and continues to grow as the project goes through design, construction, and operation.

Interoperability

Refers to the exchange of information among project participants throughout the lifecycle of a facility by direct communication between software applications.

IPD

Abbreviation for Integrated Project Delivery

Linking Files

A process of externally reference a native file into the Federated Model.

Level of Development (LOD)

Abbreviation for Level of Detail as it pertains to BIM. It used to describe the fullness and definitiveness of the Model. The LOD definition is based on the AIA E 202 – 2008 document and expanded in the Section 6.9.7.

MEP-F

Mechanical, Electrical, Plumbing and Fire Protection Systems.

Model

The term used to describe the 3D virtual representation of a Project and its Objects.

Model Element

A portion of the building information model representing a component, system or assembly within a building or site.

Model Element Author (MEA)

The party responsible for developing the content of a specific model element.

Model File

In the BIM process, the Model File contains a referenced Extraction and model file-specific information. It is recommended that Extractions not serve directly as Model Files, since if Extractions have to be regenerated, all model-specific information added to the Extractions will be lost.

Native Model

A Model created in a specific CAD platform. For example, a model made in Revit.

NBIMS

Abbreviation for National Building Information Modeling Standard

Object

The term used to describe the 3D virtual representation of each of the separate sub-parts of Model such as doors, walls, equipment etc. If an Object is, in itself, comprised of several sub-elements, the sub-elements will be grouped into one virtual representation of that Object.

OmniClass (or OCCS)

The OmniClass Construction Classification System is a classification system for the construction industry, developed by the Construction Standards Institute (CSI) and is used as a classification structure for electronic databases. As the basis of its tables, OmniClass incorporates other existing systems currently in use, including Master Format for work results, UniFormat for elements, and EPIC (Electronic Product Information Cooperation) for structuring products.

Owner Model

The term used as the final Federated model deliverable integrating the as-built model, collaboration model, and the facility model.

Parametric

Objects that reflect real-world behaviors and attributes.

Phase

A portion of work that arises from sequencing work in accordance with a predetermined portion of a stage.

Room

The term used to describe any space within the enclosing walls of the building. The space may be rectangular or more complex

SDSFIE

Spatial Data Standards for Facilities, Infrastructure, and Environment. The SDFIE Steering Group, made up of members from the Armed Forces and the U.S. Army Corps of Engineers, has set an ambitious goal of creating the Department of Defense Standard for facilities, infrastructure, environment, and civil works.

Record Drawing

Documenting as-built conditions in a drawing format.

Record Modeling

Documenting as-built conditions in a model format.

Sheet File

A CAD file or Model that shows a selected view or portion of a Model File within a referenced border sheet. Sheet files are used to generate the plotted construction sheets.

Simple Building Information Model

A concept of producing a simplified model used for simulating the building performance early in the design process.

Transferred Model

The term used to describe the Native Model(s) and/or Federated Model that are/is provided to the District for District's agreed utilization.

11 References

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GSA BIM Guide For Spatial Program Validation, Volume 2, The U.S. General Services Administration, May 2007

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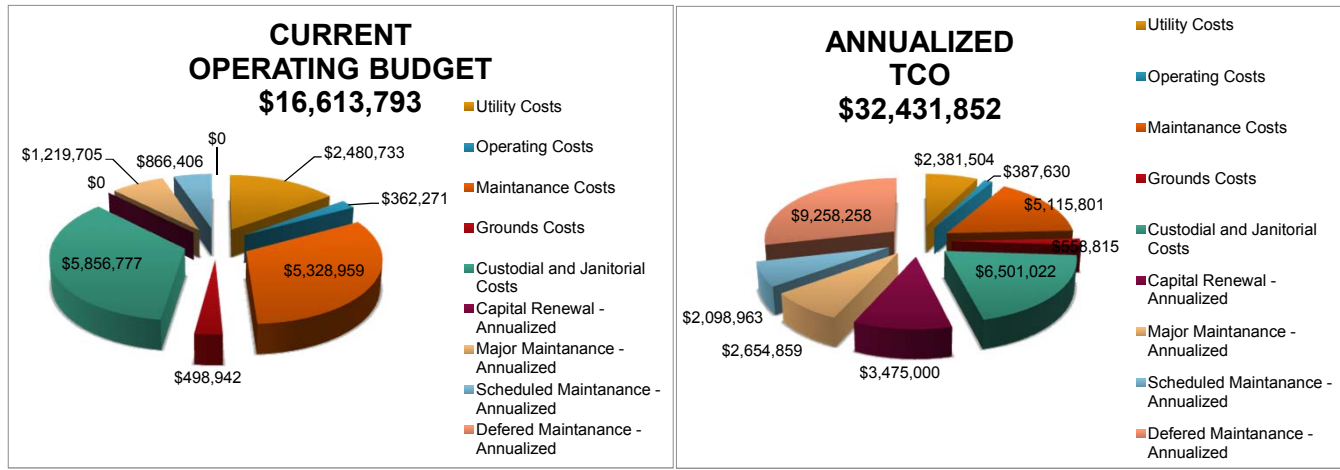
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Construction Operations Building Information Exchange (COBIE): Means and Methods, BuildingSMARTalliance (<http://www.buildingsmartalliance.org/index.php/projects/cobie>)

U.S. National CAD Standards 4.0, National Institute of Building Sciences, January 2008

Total Cost of Ownership - City College of San Francisco



INDICATORS	ASF	BUDGET ASF	COST/YR	COST ADJUST/YR	DURATION	COST Δ	TCO	TCO ASF	
OPERATING COSTS	Utility Costs	1,261,774.0	\$1.97	\$2,480,733	(\$99,229)	1 Year	-4%	\$2,381,504	\$1.89
	Operating Costs	1,261,774.0	\$0.29	\$362,271	\$25,359	1 Year	7%	\$387,630	\$0.31
	Maintenance Costs	1,261,774.0	\$4.22	\$5,328,959	(\$213,158)	1 Year	-4%	\$5,115,801	\$4.05
	Grounds Costs	1,261,774.0	\$0.40	\$498,942	\$59,873	1 Year	12%	\$558,815	\$0.44
	Custodial and Janitorial Costs	1,261,774.0	\$4.64	\$5,856,777	\$644,245	1 Year	11%	\$6,501,022	\$5.15
	Capital Renewal - Annualized	1,261,774.0	\$0.00	\$0	\$3,475,000	1 Year	100%	\$3,475,000	\$2.75
	Major Maintenance - Annualized	1,261,774.0	\$0.97	\$1,219,705	\$1,435,154	1 Year	118%	\$2,654,859	\$2.10
	Scheduled Maintenance - Annualized	1,261,774.0	\$0.69	\$866,406	\$1,232,557	1 Year	142%	\$2,098,963	\$1.66
	Deferred Maintenance - Annualized	1,261,774.0	\$0.00	\$0	\$9,258,258	1 Year	100%	\$9,258,258	\$7.34
	Total Cost Ownership/Annualized	1,261,774.0	\$13.17	\$16,613,793	\$15,818,059	1 Year	95%	\$32,431,852	\$25.70
FACILITY CONDITION	Current Replacement Value (CRV)	1,261,774	2,111,436	\$896,971,000	\$710.88	\$424.82			
	Deferred Maintenance Backlog	1,261,774	2,111,436	\$192,880,383	\$152.86	\$91.35			
	Capital Renewal	1,261,774	2,111,436	\$139,000,000	\$110.16	\$65.83			
	Building Performance Index (BPI)	Avg. Building Performance Index (BPI)			49	Target	76	\$179,215,407	0.78%
	Facility Condition Index (FCI)	Facility Condition Index (FCI)			37%	Target	11%	\$165,940,192	3.17%

OPERATING COSTS includes the following: Operations, activities related to performance of the functions for which a building is used (i.e., utilities, janitorial services, landscape and grounds services). Maintenance, which is work necessary to realize the anticipated life of a fixed asset, including buildings, fixed equipment, and infrastructure and; repairs to restore damaged or worn-out facilities to normal operating condition. Repairs are curative whereas maintenance is preventative.

DEFERRED MAINTENANCE BACKLOG is the total dollar amount of existing maintenance repairs and required replacements, not accomplished when they should have been, not funded in the current fiscal year or otherwise delayed to the future. Typically identified by a comprehensive facilities condition assessment/audit of buildings, grounds, fixed equipment and infrastructure. These needs have not been scheduled to be accomplished in the current budget cycle and thereby are postponed until future funding budget cycles.

TOTAL COST OPERATIONS/ANNUALIZED This includes all expenditures to provide service and routine maintenance related to facilities and grounds. It also includes expenditures for major maintenance funded by the annual facilities maintenance operating budget. This category does not include expenditures for major maintenance and/or capital renewal funded by other institutional accounts, or for support services such as mail, telecommunications, public safety, security, motor pool, parking, environmental health and safety, central receiving, etc.

CAPITAL RENEWAL The systematic management process of planning and budgeting for known future cyclical repair and replacement requirements that extend the life and retain the usable condition of facilities and systems, not normally contained in the annual operating budget. This includes major activities that have a maintenance cycle in excess of one year (e.g., replace roofs, paint buildings, resurface roads, etc.). The cyclical replacement may be for all or a significant portion (e.g., the replacement of 50% or more of a building system component (lighting system, roof system, etc.) as it reaches the end of its useful life, of major components or infrastructure systems, at or near the end of their useful service life.

CURRENT REPLACEMENT VALUE The total expenditure in current dollars required to replace any facility at the institution, inclusive of construction costs, design costs, project management costs and project administrative costs. Construction costs are calculated as replacement in function vs. in-kind. The value of design (6%), project management (10-12%), and administrative costs (4%) can be estimated at 20% of the construction cost. The value of property/land however is excluded, and insurance replacement values or book values should not be used to define the current replacement value.

AVERAGE BUILDING PERFORMANCE INDEX (BPI) is an indicator, scaled from 0 to 100, that assesses the physical and functional (performance) states of a facility calculated using nine principal building systems; skeleton, exterior envelope, interior finishes, electricity, sanitary Systems, HVAC, fire protection, elevators and communication. The value of the BPI index reflects the state of the building concerned, according to the following categories: BPI>80: good and better; 70 to 80 BPI, some of the systems are in a marginal condition, i.e. some preventive maintenance activities must be taken; 60 to 70 BPI, deterioration of the building, i.e. preventive and break-down maintenance activities must be carried out; and BPI≤60: the building is run-down.

OPERATING COSTS AND TARGET OPERATING COSTS PIE CHARTS show current and projected yearly operating cost with savings from planned energy savings and repair projects. The BPI and FCI shown in red are the current performance values for the the College. Those shown in green are optimal values.

FACILITIES CONDITION INDEX A comparative industry indicator/benchmark used to indicate the relative physical condition of a facility, group of buildings, or entire portfolio "independent" of building type, construction type, location or cost. The facility condition index (FCI) is expressed as a ratio of the cost of remedying existing deficiencies/requirements, and capital renewal requirements to the current replacement value (i.e., $FCI = (DM + CR) / CRV$). The FCI provides a corresponding rule of thumb for the annual reinvestment rate (funding percentage) to prevent further accumulation of deferred maintenance deficiencies. The FCI value is a snapshot in time, calculated on an annual basis. Forecasted FCI values for a building in the future, for example, would include the current deferred maintenance items, plus projected values of capital renewal requirements. The FCI is represented on a scale of zero to one, or 0% to 100%, with higher FCI values, representing poorer facility's condition. While property owners/managers establish independent standards, a "fair to good facility" is generally expressed as having an FCI of less than 10-15%.

TOTAL COST OF OWNERSHIP (TCO) is a dollar per square foot value associated with a facility. It is a calculation of all facilities-specific costs (not including furnishings or non-facility specific equipment) divided by estimated lifespan of the building (30 or 50 years), and the total gross area. Facilities specific costs include the present value of all direct, indirect, recurring and non-recurring costs incurred or estimated to be incurred in the design, development, production, operation, maintenance of an facility/structure/asset over its anticipated lifespan.

The COBie Guide:

a commentary to the NBIMS-US COBie standard

by Dr. Bill East, PhD, PE, F.ASCE¹, Mariangelica Carrasquillo-Mangual²

EXECUTIVE SUMMARY

The Construction-Operations Building information exchange (COBie) format is the international standard for the exchange of information about managed facility assets. COBie does not add new requirements to contracts; it simply changes the format of existing deliverables from paper documents and proprietary formats, to an open, international standard format.

While COBie provides the format for the exchange of required asset information, it does not provide details on what information is to be provided when, and by whom. This Guide provides best-practice guidelines for these requirements. This Guide can be considered the “commentary” that accompanies the COBie format specification.

To use this guide, customizations reflecting regional practices, specialized project types, and client’s requirements should be documented in Appendix A. The correct application of the COBie Guide may then be reference directly in appropriate specifications.

As of 2012 over twenty commercial software products support COBie. These products cover the entire facility life-cycle from planning, design, construction, commissioning to operations, maintenance, and space management. Software implementers will find the information in Appendix B helpful for low-level mapping of required properties.

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ACKNOWLEDGEMENTS

The authors of this Guide would like to thank those who participated in the three month open review of this guide that concluded on 1 October 2012. There were 1,195 world-wide views of the comments posted to the Forum. The following persons are specifically thanked for their detailed review of the original draft: Nicholas Nisbet (AEC3UK), Igor Starkov (EcoDomus), Richard Mitrenga (AutoDesk), and Marty Chabot (FMSystems). Danielle Love, formerly of the Engineer Research and Development Center, is also recognized for her original contribution to the first draft of this document.

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DRAFT

1 INTRODUCTION

Building Information Modeling (BIM) technology has demonstrated its ability to reduce overall project cost through the identification of physical conflicts between building components prior to construction. Resolving such issues during design eliminates expensive tear-out and rework during that would have otherwise occurred during construction. The use of BIM for geometric collision detection has been the starting point to understand the potential use of building information.

The buildingSMART alliance³ has begun to unlock the non-geometric information content in BIM through the standardization of contracted information exchanges that will eventually replace the paper-based document exchanges currently specified by contracts. The goal of these standards is to provide the required information content when created, and securely share and update specified portions of that information with authorized team members as the project proceeds.

Rather than producing wasteful paper documents whose content is impractical to extract, multiple times during a facility life-cycle, standard information exchanges streamline current process to eliminate waste and increase profitability. The first of these standards, the Construction-Operations Building information exchange (COBie⁴) delivers facility asset information. These assets are simply the scheduled equipment, products, and spaces that appear on design drawings.

Readers unfamiliar with COBie should begin by watching the following two on-line presentations:

- Class 1. Overview⁵
- Class 2. How To⁶

It is assumed that readers of this document have viewed these two on-line presentations.

2 PURPOSE OF THIS COBie GUIDE

The purpose of this Guide is to identify the requirements of COBie deliverables for design and construction contracts. This document is not a software user manual.

There are two parts to this document. First are common requirements to be met regardless of client. The second part is the set of client-specific requirements that must be met in addition to the general requirements. Client-specific requirements may be found in “Appendix A – Owner’s Requirements.”

³ buildingsmartalliance.org A Council of the National Institute of Building Sciences.

⁴ wbdg.org/resources/cobie.php The COBie homepage.

⁵ youtube.com/playlist?list=PL9E7A408B074B90C9&feature=plcp COBie College. Class 1. Overview.

⁶ youtube.com/playlist?list=PL9703BB3F0E9EACA9&feature=plcp COBie College. Class 2. How To.

There are over twenty commercial off the shelf software products that support the production and/or consumption of building asset information through COBie. Instructions on using these systems to produce or consume COBie data must be obtained directly from the software company.

The results of independent software testing conducted by the National Institute of Building Sciences are documented on the COBie Means and Methods web page⁷. Given the differences in software configuration and version, those producing or consuming COBie deliverables using commercial software solutions should conduct their own test using any one of three common test models⁸.

3 THE COBie PROCESS

The process of creating COBie deliverables follows the same processes used in today's design and construction. COBie simply transforms the information provided in paper documents into information that can be re-used through the project. The figure below summarizes the COBie process.

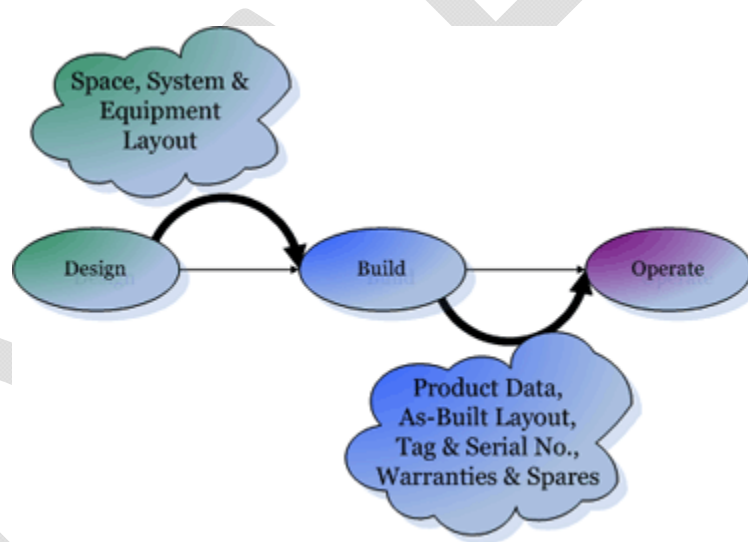


Figure 1. COBie Process

During early design, Architects develop the spaces and groups of spaces needed to support the activities required by the owner program brief. This information is delivered through the Schematic Design drawings. COBie delivers the subset of the Schematic Design information related to spaces, zoning, and “room data sheets.” Schematic Design stage COBie information is used to verify that the facility being designed meets the owner’s program brief. Since COBie is an extract from the Schematic Design deliverables, the information in COBie data files must match

⁷ buildingsmartalliance.org/index.php/projects/cobie The COBie Means and Methods page.

⁸ buildingsmartalliance.org/index.php/projects/commonbimfiles/ The Common BIM file page.

the information about spaces and architectural products and schedules found on Schematic Design submittal.

As the design nears completion, Engineers design the systems that deliver the required services, such as electricity, water, appropriate temperature, fire protection, security, etc... to allow the activities to take place. This information is delivered at the Construction Documents design stage. In addition to the updated architectural information, COBie delivers the subset of the Construction Documents information related to the product and equipment assets that will ultimately be managed by the owner. This asset information is found in the design drawing's equipment and product schedules. Since COBie is an extract from the Construction Documents Design deliverables, the information in COBie should be a perfect match for the printed on the drawings from that deliverable.

During construction, the generic asset information found in the Construction Documents stage is filled-in to provide the COBie construction deliverables. A COBie submittal prior to Beneficial Occupancy allows the facility manager to begin efficiently operating their facility upon occupancy. A COBie As-Built submittal is also provided to reflect all final changes and as-built conditions. During construction this information is linked from other sources such as documents containing approved submittals, warranty certificates, etc... As a result construction information may be gleaned directly from electronic submittal records. Other information, documenting the specific installation and testing of equipment, includes some specific information such as serial number and installation dates for every major building asset. The resulting data set is no more, or no less, than a set of Operations and Maintenance Manuals that can actually be used by operations, maintenance, and asset management personnel.

Following the delivery of facility asset, maintenance and operations information the owner will load this information directly into their COBie compatible maintenance management system and immediately begin the efficient operation of that facility. Updates to COBie data resulting from work orders should be documented directly in next-generation maintenance management systems. Results of renovations simply update that subset of existing COBie data with the changes coming from the renovation project.

4 The COBie BUSINESS CASE

The delivery of COBie is not a new requirement. COBie, from the designer's side, is simply a report from the existing design of the assets to be delivered. COBie, from the contractor's side, transforms current paper deliverables into data to operate the facility. Participants on projects requiring COBie can create the deliverables in the same way as they produce the current paper documents, or use this new format as an opportunity to eliminate wasted time and effort associated with the production of after-the-fact, error-prone paper documents. In this view, COBie is the direct application of "lean" methodologies to eliminate non-productive waste in administrative contracting procedures.

Here is one example where current process can be transformed, with the right set of technologies, to eliminate wasted effort associated with the production of paper Operations and Maintenance Manuals. This current labor intensive process to create O&M Manuals includes a physical “job crawl” to collect equipment nameplate information followed by man-months of collation of existing documents into O&M binders. The contract may also elect to capture electronic submittals and installation information as they occur and reduce their cost.

The National Institute of Building Sciences is developing a COBie Calculator that will provide a life-cycle review of the cost of such waste and the savings that may be achieved. When published in January 2013, the COBie Calculator and associated reports may be found through the Whole Building Design Guide’s COBie homepage⁹.

5 TEAM RESPONSIBILITIES

During the course of a project, different team members have primary responsibilities to create COBie deliverables. Given that many teams will use Building Information Modeling tools, particularly during the design stage, to create the required contract drawings, the identification of COBie responsibilities should be explicitly included in the team’s **BIM Execution Plan**.

One tool that can assist teams in identifying responsibilities with respect to the production of COBie deliverables is the COBie Responsibility Matrix¹⁰. This matrix allows the team to color code different parts of a COBie deliverable to define precise requirements as to what individual, from which relevant firm, will be responsible for the production of specific data within COBie.

While project teams will define specific individuals responsible within their firms, the following general responsibilities for the production of COBie data should be observed.

1. Regardless of the form of contract the Architectural firm is responsible for Design Development (35% Design) Deliverable.
2. Regardless of the form of contract, the Architectural Firm is responsible for the Coordination of all design Disciplines input to the Construction Document Design (100%) Deliverable.
3. Regardless of the form of contract, the General Contractor shall be responsible for the Beneficial Occupancy and the As-Built Construction Deliverables.
4. For projects that employ Third Party commissioning, the Commissioning Agent may assist the General Contractor to coordinate and validate the quality of the General Contractor deliverables at the Beneficial Occupancy and the As-Built Construction Deliverables.

⁹ wbdg.org/resources/cobie.php The COBie homepage.

¹⁰ projects.buildingsmartalliance.org/files/?artifact_id=4093 COBie Responsibility Matrix.

6 COBie DELIVERABLES

The requirements for the timing of COBie deliverables on typical facility acquisition projects are provided in this section. Participants in specific contracts should review individual contract requirements for any changes to these general requirements, including, but not limited to, Appendix A of this document.

One COBie file shall be provided for each facility on the project. If there are multiple facilities, then an additional COBie file identifying the assets for the Site, shall also be provided.

Information found in a COBie file shall accurately reflect the associated information on design and as-built drawings schedules at that stage of the project. All COBie files are to be submitted for client approval. A sufficient portion of the progress payment for the overall deliverable package shall be withheld for non-compliant COBie deliverables to cover the potential cost of manually creating accurate COBie deliverables.

COBie deliverables increase in content over time to reflect the increasing maturation of the design or completion of the construction project. Refer to “Deliverable Evaluation Criteria” for the content required at each deliverable. In addition, refer to “Asset Requirements” for a minimum list of assets to be included in the model and minimum required properties for such assets.

All deliverables shall comply with the Facility Management Handover Model View Definition as described in the National BIM Standard – United States. Unless otherwise specified COBie deliverables shall be provided in Industry Foundation Class (IFC) file format (STEP-Part 21) or COBie 2.4 spreadsheet format. Files referenced in the COBie.Documents worksheet shall be provided with the COBie file submission in Portable Document Format (PDF), Tag Image File Format (TIFF), or Joint Photograph Experts Group (JPEG).

Design Development Deliverable (35% Design)

Regardless of the form of contract, the Architectural firm is responsible for Design Development (35% Design) Deliverable. This phase may also be referred to as the Schematic Design phase.

The Design Development Deliverable shall be provided in a single file for each facility in the project (and site, if applicable) containing design information developed by those in the Architectural discipline. The focus of the design development deliverable is to provide an accurate representation of space and architectural facility assets. Space asset attributes shall be completed to allow the presentation of room data sheet reports corresponding to the level of detail found in the associated drawings.

Architectural product types, such as door and window schedules, shall be identified if such assets are found on the associated drawings. If plumbing and lighting assets are found in the associated drawings, then these assets shall be identified in the information deliverable as well.

The Design Development Deliverable shall also identify the expected systems required to provide heating, cooling, electricity, water, fire protection, and other services. At this stage of the design,

the system information provided shall be in name and classification only without reference to the specific components that comprise these systems. All such information is provided, in detail, during the next stage of design.

The content of the deliverable shall be evaluated based on compliance with the data format (either IFC or spreadsheet) and content. The COBie worksheets (or equivalent IFC file data) listed in the figure below shall be provided as noted in the “Asset Requirements” and “Deliverable Evaluation Criteria” sections. The purpose of these requirements is to standardize product and equipment schedules on design drawings and have the information in those schedules reflected in the associated COBie deliverable.

The content of the Design Development Deliverable shall reflect the space and scheduled products and equipment assets as presented on the corresponding deliverable drawings. The Architect is responsible to correct all deviations in content between the associated Design Development drawings and the information deliverable described in this section.

Table 1. Schematic Design COBie Deliverable

COBie Worksheet	Required Content
Contact	One row for the designer’s BIM manager shall be provided.
Facility	One facility per COBie file.
Floor	One row for each vertical level to include foundations, floors, roofs, and site.
Space	One row per functional space, per room. Mult. spaces in a room possible.
Zone	One row for each COBie.Space and COBie.Zone type.
Type	One row for each scheduled product type found on design drawings.
Component	One row for each individual scheduled product found on design drawings.
System	One row for each system to be defined in the next stage of design.
Document	One row for each associated deliverable document linked to relevant sheet.
	One row listing URL of target product COBie.Type selected.
Attribute	One row for each required COBie.Space Attribute.
	One row for each required COBie.Type Attribute.
	One row for each required COBie.Component Attribute.

Construction Documents Design Deliverable (100% Design)

Regardless of the form of contract, the Architectural Firm is responsible for the coordination of all the input from the design disciplines to the Construction Document Design (100%) Deliverable.

If COBie data at the Construction Documents Design stage is extracted from multiple BIM files each of the required BIM files shall be provided as a part of that COBie deliverable. Regardless of the native file format for BIM models, a single merged COBie file shall be provided for each facility in the project (and site, if applicable). This set of COBie files shall be the basis for client evaluation of the submittal. The party submitting the COBie file shall be responsible to verify that the submission does not contain duplicative assets or geometry. Models with duplicate assets or geometry shall be disapproved by the client.

The content of the deliverable shall be evaluated based on compliance with the data format (either IFC or spreadsheet) and content. The COBie worksheets (or equivalent IFC file data) listed in the figure below shall be provided as noted in the “Asset Requirements” and “Deliverable Evaluation Criteria” sections. The purpose of these requirements is to standardize product and equipment schedules on design drawings and have that standardization reflected in the product and equipment information delivered.

Table 2. Construction Documents COBie Deliverable

COBie Worksheet	Required Content
Contact	One row for the designer’s BIM manager shall be provided.
Facility	One facility per COBie file.
Floor	One row for each vertical level to include foundations, floors, roofs, and site.
Space	One row per functional space, per room. Mult. spaces in a room possible.
Zone	One row for each COBie.Space and COBie.Zone type.
Type	One row for each scheduled product type found on design drawings.
Component	One row for each individual scheduled product found on design drawings.
System	One row for each COBie.Component identifying the related COBie.System.
Document	One row for each associated deliverable document. Linked to relevant sheet.
	One row listing URL of target product COBie.Type selected.
Attribute	One row for each required COBie.Space Attribute.
	One row for each required COBie.Type Attribute.
	One row for each required COBie.Component Attribute.

There are two primary differences in the deliverables at the Design Development and Construction Documents stage.

First, the content of the Construction Documents Deliverable shall reflect the complete set of all spaces, scheduled products, and equipment assets as presented on the corresponding deliverable drawings. At the Construction Documents stage this list of products and equipment is expected to be complete. The attributes of the scheduled properties of these products will be updated to reflect the attributes reflecting the Basis of Design. Again, this is no different than simply lifting the information from Construction Document stage drawings and providing that information in the COBie open standard format.

The second difference in deliverables between Design Development and Construction Documents stage is that the Construction Document stage model groups products and equipment into the systems that provide specific services throughout the building.

As with design drawings at the Construction Documents stage, the Architect’s responsibility to coordinate design drawings of multiple disciplines extends to the Architect’s responsibility to ensure that the data provided from these design drawings is also coordinated.

Beneficial Occupancy Construction Deliverable

The General Contractor shall be responsible for the Beneficial Occupancy and the As-Built Construction Deliverables. For projects that employ Third Party commissioning, the Commissioning Agent may assist the General Contractor to coordinate and validate the quality of the General Contractor deliverables at the Beneficial Occupancy and the As-Built Construction Deliverables.

The following COBie worksheets (or equivalent IFC file data) shall be provided as noted in the “Deliverable Evaluation Criteria” section.

The Beneficial Occupancy Construction Deliverable will be provided as a single COBie file for each facility in the project (and site, if applicable) that reflects the as-installed and commissioned facility at the time of beneficial occupancy. This file shall update the Construction Documents model to reflect any additions, updates, or deletions to the underlying buildings and associated COBie data. The complete set of commissioning information completed at the time of beneficial occupancy shall be provided with this deliverable. The attributes of the scheduled properties of installed products will be updated to reflect any differences between installed equipment and attributes reflecting the basis of design. Information needed to operate and maintain the occupied portions of the facility shall also be included in this COBie deliverable.

Table 3. Beneficial Occupancy COBie Deliverable

COBie Worksheet	Required Content
Contact	One row for the designer’s BIM manager shall be provided.
Facility	One facility per COBie file.
Floor	One row for each vertical level to include foundations, floors, roofs, and site.
Space	One space per functional use.
Zone	One row for each COBie.Space and COBie.Zone type.
Type	One row for each scheduled product type found on design drawings.
Component	One row for each individual scheduled product found on design drawings.
System	One row for each COBie.Component identifying the related COBie.System.
Spare	Row(s) for each spare, part, or lubricant for each COBie.Type
Resource	One row for each material, labor, training, or other required resource
Job	Row(s) for each COBie.Type identifying PM Schedules
	Row(s) for COBie.Types identifying Operations Schedules
	Row(s) for COBie.Components identifying Operations Schedules
Document	Row(s) for each COBie.Type listing each approved submittal document.
	Row(s) for each COBie.Type listing all commissioning submittals.
	Row(s) for each COBie.Component listing all commissioning submittals.
	One row for a photograph of each COBie.Component equipment nameplate.
Attribute	One row for each required COBie.Space Attribute.
	One row for each required COBie.Type Attribute.
	One row for each COBie.Component equipment nameplate information

As-Built Construction Deliverable

The General Contractor shall be responsible for the Beneficial Occupancy and the As-Built Construction Deliverables. For projects that employ Third Party commissioning, the Commissioning Agent may assist the General Contractor to coordinate and validate the quality of the General Contractor deliverables at the Beneficial Occupancy and the As-Built Construction Deliverables.

The COBie worksheets (or equivalent IFC file data) required at Beneficial Occupancy shall be provided as noted in the “Deliverable Evaluation Criteria” section.

The As-Built Construction Deliverable will be provided as a single COBie file for each facility in the project (and site, if applicable) that reflects the as-built design documents delivered as fiscal completion of the project. This file shall update the Beneficial Occupancy Deliverable model to reflect any additions, updates, or deletions to the underlying buildings and associated COBie data. The complete set of commissioning information shall be provided with this deliverable. Information needed to operate and maintain the facility shall also be included in this COBie deliverable.

7 DELIVERABLE EVALUATION CRITERIA

COBie models must conform to all format and business rules found in NBIMS-US. Quality requirements must be met by a combination of the use of COBie tested software and use of that software in accordance with manufacturer’s recommendations. The quality guidelines identified in this section are issues that have arisen during software testing due to incorrect software configuration or incorrect use of that software. The project team is responsible for understanding how to use their selected software to ensure compliance.

In addition, there may be client-specific requirements found in more specific contract requirements. Participants in specific contracts should review individual contract requirements and Appendix A of this document for clarifications or changes to these general requirements.

COBie files that do not meet the requirements of NBIMS-US, including those rules specifically highlighted below, and owner-specific requirements shall be required to be manually corrected and resubmitted until approved by the client.

One Facility Per COBie File

COBie represents the set of assets managed in an individual facility. If there are multiple facilities and common site work associated with a given project, the COBie files shall be prepared for each individual facility. Site work shall be identified in a separate COBie site-file even for stand-alone facilities.

It is the responsibility of the designer, consultant, or contractor team member designated in the team's COBie implementation plan to ensure that information from multiple sources can be easily integrated to produce a single set of COBie information for each facility, at each deliverable stage, such that the information in the COBie file matches the information found on the design drawings.

If specific sets of tools are provided by your current agency to support integration efforts, these tools will also be listed in "Appendix A – Owner's Requirements".

Unique Asset Naming

Without unique names, specific assets cannot be effectively maintained. All managed spaces, products and equipment found on design schedules and drawings shall be uniquely named. These names must provide information about the asset outside the context of the design schedule. The names on the design drawings must match those found in the COBie deliverable.

During design, the Architect shall be responsible to resolve all conflicts in duplicative naming by their own staff and all consulting engineers. Software's failure either through configuration, setup, use, or underlying inability to implement unique naming algorithms shall require the Architect to manually update all effected drawings, building models, and COBie files.

During construction, the General Contractor shall be responsible to resolve all conflicts in duplicative naming of Component's in addition to those delivered during the design stages. Software's failure either through configuration, setup, use, or underlying inability to implement unique naming algorithms shall require the General Contractor to manually update all effected drawings, building models, and COBie files.

The following are the minimum quality guidelines related to COBie asset naming to be applied on the subject contract.

COBie.Space.Name Quality Guidelines

- Each value in this Column shall be unique.
- The characters in this field shall be found within the range of ASCII characters between [0-9], [a-z], [A-Z], and the two symbols dash (" - ") and underline (" _ "). Unless otherwise noted the ASCII space characters, CHR(20), in Name fields is prohibited due to the inconsistency of parsing software. Other characters, including non-printing ASCII control characters are expressly prohibited.
- One COBie.Space row shall be provided for each functional area in every physical room in every facility. For large rooms with multiple functional areas, spaces shall be defined for each of the functional areas and designated with a dash followed by a letter designation starting with "A" and working through each of the subsequent spaces.

- COBie.Space.Name's shall exactly match the space names shown the related design and construction deliverables.
- COBie.Space.Tag field shall be used for building signage.
- COBie.Space.Name requirements for unique naming of functional areas shall extend to different work areas on large roofing spaces or discrete geographic regions in site models.
- COBie.Space.Description values not published on contract drawings shall have generic space descriptions.

COBie.Type.Name Quality Guidelines

- Each value in this Column shall be unique.
- The characters in this field shall be found within the range of ASCII characters between [0-9], [a-z], [A-Z], and the two symbols dash ("-") and underline ("_"). Unless otherwise noted the ASCII space characters, CHR(20), in Name fields is prohibited due to the inconsistency of parsing software. Other characters, including non-printing ASCII control characters are expressly prohibited.
- Scheduled equipment and products found on the drawings shall be uniquely named.
- Unless otherwise specified by the client, the name of each COBie.Type of product and equipment shall begin with a signifier of the product type that would be recognizable to a facility manager outside the context of the specific design. For example, the designation "DOOR-A" uniquely distinguishes that COBie.Type from the light fixture type "LIGHT-A".
- The designer shall either utilize client supplied template objects or explicitly coordinate the names of all product types, in advance, with the owner and document all decisions.

COBie.Component.Name Quality Guidelines

- Each value in this Column shall be unique.
- The characters in this field shall be found within the range of ASCII characters between [0-9], [a-z], [A-Z], and the two symbols dash ("-") and underline ("_"). Unless otherwise noted the ASCII space characters, CHR(20), in Name fields is prohibited due to the inconsistency of parsing software. Other characters, including non-printing ASCII control characters are expressly prohibited.

- Individual instances of each type must also be unique. For large pieces of scheduled equipment such as Air Handling Units, such unique naming is commonly found on design schedules.
- Unless otherwise specified by the client, for items where design schedules describe only the asset types, such lighting or plumbing fixture schedules, the following formula for creating a unique component name shall be used.

COBie.Type.Name & “-” & COBie.Space.Name & “-” & Item Count in Space.

For example, if there were two sinks of type “Sink-A” in space “100” the unique names of each of these components following the algorithm shall be “Sink-A-100-01” and “Sink-A-100-02”.

COBie.Type Product Specification

During the course of the COBie deliverables the specificity of information about COBie.Type will typically increase from a notional performance specification, to identification of the Basis of Design of specific manufacturer, to the product actually approved and installed by the Contractor. Given the differences between various software products implementing COBie and their treatment of this product life-cycle, requirements for Basis of Design documentation shall be identified as specified in this document.

Component Spatial Containment

All COBie.Component records shall be identified in the COBie.Space in which the asset is found or the COBie.Space from which the asset is operated.

Component Spatial Placement

A COBie.Attribute named “SpatialPlacement” shall be provided for each COBie.Component. This Attribute identifies information needed by the facility manager, operator or maintainer to access that component. Typical values of the SpatialPlacement Attribute shall include “UnderFloor”, “AboveCeiling”, “InWall”, “InSpace”, “OnRoof”, “OnSite”.

Site Spatial Containment

For each facility compound or campus with shared site work, a separate COBie Site file shall be submitted. A single COBie.Floor row will be created for this site file and identified as a COBie.Floor.FloorType of “Site.” Definable areas within that site will be identified in rows in the COBie.Space worksheet. Examples of typical COBie.Space rows within COBie.Floor=Site’s are parking lots, utility pads, loading docks, etc... The default list of Site spaces that shall be included for a given client are identified in Appendix A.

Facility Geo-location

To ensure coordination of COBie data with campus-management and Geographic Information Systems, the following COBie.Attributes shall rows be provided for each COBie.Facility Record based on (in the Northern Hemisphere) the “lower left-hand spatial” coordinate of each facility.

- Longitude
- Latitude
- Elevation
- Rotation

Categories

Large public clients manage different types of facilities on multiple campuses. To effectively manage these portfolios, COBie deliverables are required to receive building information in a consistent way. In COBie this is accomplished through the use of several different types of Classifications. Classifications are “category codes” of different types used in COBie. The NBIMS-US requires classification for the following COBie worksheets.

- Contact
- Facility
- Space
- Type
- System

NBIMS-US designates OmniClass¹¹ as the default classification method used if no other method is specified in contract. The default list of mandatory COBie Classifications that shall be included for a given client are identified in Appendix A.

Note that a client’s reliance on OmniClass alone may not ensure cross-project compatibility over time. The OmniClass classification tables, just like all classification systems, change over time as updates are incorporated. It is to the clients benefit to determine and publish the precise classification scheme required across all projects.

Zones

Buildings contain groups of spaces that, when connected, provide specific capabilities to the owner. The COBie.Zone worksheet is designed to identify the spaces that make up a given zone.

In general, zones shall be identified by zone type and characteristics. Zones naming in large facilities shall also be identified floor and wing appended. The names of zones and sub-zones shall be approved by the owner. The default list of zones that shall be used for a given client are identified in Appendix A.

¹¹ omniclass.org/ OMNIClass Construction Classification System.

A COBie.Space may only be listed once for a given type of zone. A COBie.Space may, however, be part of multiple types of zones.

As an example consider Space “100” in a building where “Circulation Zone” and “Fire Protection” zoning information is required by the owner. In this example Space 100 could be part of the “Circulation Zone - Public” Circulation Zone and the “Fire Protection Zone - First Floor West Wing” Fire Protection Zone. It is not, however, possible for Space 100 to be part of both the “Fire Protection Zone - First Floor West Wing” and “Fire Protection Zone - First Floor East Wing” zones.

Zones may be nested. Nesting must be accomplished through the name of the zone. For example, there may be shared spaces that support both the “Fire Protection Zone - First Floor West Wing” and “Fire Protection Zone - First Floor East Wing” zone. Such zones can be identified in the “Fire Protection Zone - First Floor” zone.

If agreed to by the project team, the nesting of zones may be accomplished through the use of COBie.Attributes that identify the ParentZone of the current zone.

Systems

Buildings contain groups of components that, when connected, provide specific required services. The COBie.System worksheet is designed to identify the components that make up a given system. In general, systems shall be identified by building service, floor and wing. The names of systems within each system type shall be approved by the owner. Subsystems, if required, shall be identified using an owner-approved naming convention. The list of systems possible for a typical project for your current agency may be found in “Appendix A - Owner’s Requirements”.

A COBie.Component may only be listed once for a given type of system. A COBie.Component may, however, be part of multiple types of systems.

As an example consider Component “Sensor – Temperature 101” in a building where “HVAC system” and “Sensor System” information is required by the owner. In this example, the sensor could be part of both the “HVAC System – Chilled Water” and the “BAS System – HVAC Sensors” system. It is not, however, possible for the sensor to be part of both the “HVAC System – Chilled Water” and “HVAC System – First Floor Heating Distribution” system.

Systems may be nested. Nesting must be accomplished through the name of the system. For example a Fire Protection System may have a set of equipment supporting “Fire Protection – Common” and equipment supporting specific areas of the building such a “Fire Protection – First Floor, West Wing” and a “Fire Protection - First Floor, East Wing”.

A question that may come up is the relationship between systems and zones. This is relevant since some systems and zones have overlapping boundaries. The link can be directly found in the COBie data specification from either the direction of components or spaces. To find the COBie.Components and COBie.Systems that support specific spaces, a query can be made to look

for all components that are found in the COBie.Spaces identified within a given COBie.Zone. The inverse query can also be made to identify the COBie.Spaces supported by a given COBie.System.

If agreed to by the project team, the nesting of systems may be accomplished through the use of COBie.Attributes that identify the ParentSystem of the current system.

Units of Measure

COBie models require a single standard set of units of measure for linear, area, and volumetric measures. This unit of measure standard is applied on all units that do not otherwise have units attached. Designers shall designate the required units of measure for their projects for owner approval prior to starting design. All other disciplines shall be required to use the same units of measure defined by the designer.

The architectural model and all other models shall be oriented to “project” north. The difference between project north and magnetic north shall be defined by the architect. The designer shall designate the elevation of the project for a single origin point. Latitude and Longitude shall be defined based on the single origin point. All other disciplines shall be required to reference the project north rotation and elevation origin point designated by the designer.

Units on attributes shall be required to be identified with each numeric value in the COBie.Attributes worksheet. This applies regardless of the type of Attribute being provided.

Given the differences in software implementation of units, it is critical that the design team evaluate their product using small testing models to ensure that this requirement can be met. It would be expected that commercial product COBie points of contact will need to be identified and contacted to reduce post-design or post-construction manual updating of COBie deliverables.

During design the Architect shall be responsible for the manual update of all COBie.Attributes not automatically provided by design software. During construction the Contractor or Commissioning Agent shall be responsible for the manual update of all COBie.Attributes not automatically provided by software used to create their required deliverables.

Use of Commercial Software

Many commercial products can produce COBie data automatically. It is critical, when using these products, that the software vendor’s set-up instructions are followed prior to the use of that software. Without the correct initial configuration, the designer, commissioning agent, or contractor may be required to rekey by hand the information required in COBie deliverables.

All COBie deliverables shall be accompanied by a report that demonstrates that the file provided meets the formatting requirements of the COBie specification.

Different checking tools have different capabilities. Some check both IFC-based and spreadsheet-based files. Others only check spreadsheet-based files. The list of available tools maybe found on the COBie Means and Methods Page¹².

If there are specific checking tool requirements for a given owner, these may be found in “Appendix A – Owner’s Requirements”.

Multiple-Model Merging

Given the variety of technology, approaches to providing COBie data, and newly emerging practical expertise in merging COBie data, special concern should be paid by those preparing COBie deliverables from multiple underlying source files. The discussion below may help to clarify these issues for those who attempt to aggregate COBie data from multiple sources.

There are two general classes of problems that may be encountered. In the first case, problems are rooted in design practice. In the second cases problems stem from incomplete adoption open standards by software firms.

Consider the workflow in the Design Development stage when an Architect will produce a reflected ceiling plan contains lighting fixtures and plumbing fixture schedule. Later during Construction Documents stage the electrical Engineer’s lighting fixture schedule and mechanical Engineer’s plumbing fixture schedule will be completed. It is sometimes the case in design practice that such information will not exactly match. The general rule to interpreting drawing inconsistencies is that the more detailed information governs over less detailed information. The practical impact of this rule is that the construction bids will almost always be made against the electrical lighting fixture schedule and not the Architect’s reflected ceiling plan.

The second type of issue that may impact on the merging of COBie data from multiple sources is that software that imports the Architects original model may not maintain unique Space, Type or Component names. In some cases when the data from this additional software is merged back into a single file multiple spaces and equipment and associated properties and geometry may be found.

It is recommended that when preparing a COBie deliverable from multiple models that a “pre-flight” check of model merging operations be conducted to determine if assets are duplicated in different models. If automated methods for supporting design quality control are not available by the design team’s commercial software product, the designers’ BIM manager will have to complete this review and/or merging manually.

If there is a question regarding the order of precedence in merging, then merging should follow standard contract interpretation rules of precedence. The standard approach is that more precise information (provided by a respective design discipline) takes precedence over the more general Architectural information. A specific set of rules should be developed by the team when merging

¹² buildingsmartalliance.org/index.php/projects/cobie The COBie Means and Methods page.

multiple files. The buildingSMART alliance¹³ has currently published a document containing an example set of merging rules at the construction document stage.

8 EQUIPMENT AND PRODUCT REQUIREMENTS

COBie delivers information about managed assets. Spatial assets shall be identified in the COBie.Space worksheet and have properties corresponding to architectural Room Data Sheets as specified by the client. Equipment and product assets described in this section appear in the COBie.Type and COBie.Component worksheets. Attributes of such assets appear in the COBie.Attribute worksheet.

It is a requirement of COBie Challenge events beginning in January 2013 that all software producing or using COBie data provide explicit end-user instructions regarding the application of regional-, national-, or client-specific property sets. An example of a regional property set project underway in the United States is the Specifiers Properties information exchange (SPie) project. In the future, it is expected that clients will specify the use of prepared template objects with mandatory properties that reflect their unique requirements.

In absence of client-specified regional-, national-, or client-specific property sets, the project team may develop equipment and product schedules according current business practices, and submit for client approval these schedules that will be reviewed against the quality standards identified in this Guide. When developing equipment and product schedules, designers and consultants shall ensure that schedule headings are normalized to eliminate duplication, resolve synonyms between disciplines, and consistently name objects to provide information upon which the facility may be efficiently maintained, operated, and managed. Units for all attributes shall also be identified and coordinated between designers and consultants.

Regardless of the source of the properties specified in client contracts, COBie.Attributes for all COBie.Type and COBie.Component records shall match the properties found on equivalent design drawing equipment and product schedules.

Section 8.1 identifies common COBie quality attributes that apply to all projects, regardless of regional-, national-, or client-specific property sets. Sub-sections beginning with section 8.2 identify properties identified by asset type. These are listed in rough order of the tempo of required maintenance and operational activities for those assets. Those assets requiring the most attention appear toward the top of the list.

8.1 General Requirements

The following requirements shall govern the delivery of all types of equipment and products found in all COBie deliverables.

¹³ buildingsmartalliance.org A Council of the National Institute of Building Sciences.

8.1.1 Project Team Responsibility

In absence of specified regional-, national-, or client-specific property sets, the project team shall pre-coordinate the identification of required equipment and product properties. Documentation of this pre-coordination shall be submitted for client approval prior to the start of design. This submittal shall include the list of scheduled equipment and product schedules and the headings expected to appear on all drawings schedules. This submittal shall be provided for client approval.

The purpose of this pre-coordination submittal is to eliminate later possible re-work by the project team that may be needed to bring COBie deliverables up to the data quality standards identified in this Guide.

The client may explicitly require that the project team conform to the properties provided in this Guide. These properties were selected from design schedules found in standard designs of several United States federal government agencies. That information was collated, normalized to eliminate duplication and resolve synonyms, and consistently organized in the tables provided in this section. Units for each Attribute have also been identified. The effort taken to resolve such issues in this Guide is expected to save the project team a significant amount of effort until such time as regional, national, or client-specific requirements are completed.

The first check of COBie data quality conducted by the client shall be a review of all scheduled equipment and products. If there are discrepancies, the client shall reject the COBie deliverable and hold retainage until such time as the COBie quality standards are met. The client's retainage of the COBie deliverable shall be based on the time required to manually document all scheduled assets.

8.1.2 Unique Component Name and Type Name

All equipment schedules that identify individual components shall begin with the attributes listed below. The asset's name "Component.name" and asset type name "Component.Type" provided in all design schedules shall be unique across all classes of asset.

- Name
- Type

A default naming scheme for schedules that identify individual components and those which only identify equipment or product types was provided previously in this Guide.

8.1.3 Non-Substantive Attributes

Attributes provided in COBie deliverables shall be restricted to those that provide information about the specification or operation of the managed asset and not information pertaining to the internal configuration of the software system or output formats provided by the implementing software systems.

8.1.4 Type versus Component Attributes

Attributes in common across a given equipment or product Type shall be associated with the COBie.Type record. Attributes unique to a specific Component may be associated with the COBie.Component record.

8.1.5 Specification Reference

At the Construction Documents deliverable and beyond all COBie.Type records shall be identified with the specification section that references their requirements. This shall be accomplished by the COBie.Type Attribute called "SpecificationSection."

8.1.6 Electrical Properties

All equipment schedules that identify individual components that use electrical power shall have the next three headings of their schedules contain the following asset information. This information shall be included in the COBie file as attributes on the asset Type.

- Current
- Voltage
- Frequency

8.1.7 Placement

All managed assets shall be identified by its placement within the facility. At the construction Documents Design stage this requirement will apply to all COBie.Component records using the COBie.Attribute "SpatialPlacement". At the Beneficial Occupancy and As-Built stages of construction, this requirement will apply to both scheduled and tagged assets. The values that can be used for the "SpatialPlacement" attribute shall include, but not be limited to, the following list.

- AboveCeiling
- InSpace
- InWall
- OnRoof
- OnSite
- UnderFloor

8.1.8 Construction Documents Deliverable - Basis of Design

These properties shall be added to the COBie.Attribute worksheet and associated with every COBie.Type record at the Construction Documents (100% Design) Deliverable. The field "BasisOfDesign-Notes" reproduces notes associated with each type of scheduled assets as found on design drawings.

- BasisOfDesign-Manufacturer
- BasisOfDesign-ModelNumber
- BasisOfDesign-Notes

8.1.9 Occupancy and As-Built Deliverables – As-Installed Common Properties

The Beneficial Occupancy and As-Built COBie deliverables shall update the following additional attributes of all designed assets based on the properties of installed products.

COBie Worksheet	COBie Field
Type	Manufacturer
Type	ModelNumber
Type	WarrantyGuarantorLabor
Type	WarrantyDurationLabor
Type	WarrantyDurationUnit
Attribute (of Type)	ApprovedDeviations
Component	SerialNumber
Component	InstallationDate
Component	TagNumber

8.1.10 Occupancy and As-Built Deliverable – As-Installed Electrical Circuit

Each scheduled/named asset that uses electricity, shall in addition to other required properties, have the following two properties that identify the electrical circuit required to de-energize that equipment. These properties will be added to the COBie.Attribute worksheet for the Beneficial Occupancy and As-Built COBie deliverables.

- ElectricalPanelName
- ElectricalPanelCircuit

8.1.11 Occupancy and As-Built Deliverables – As-Installed Systems of Components

Each scheduled/named system asset shall be identified in the COBie.System worksheet to identify the grouping of different components into systems within the facility.

8.1.12 Occupancy and As-Built Deliverables – As-Installed Assemblies of Components

Engineered-to-order products are assembled of individual products that have different preventative maintenance schedules and replacement parts requirements. To correctly include these in COBie there must be a COBie.Type and COBie.Component for both the assembly and for the individual pieces of equipment within the overall assembly. BOD and As-Built Deliverables – Required Type Properties

The Beneficial Occupancy and As-Built COBie deliverables shall update the attributes of all scheduled asset Types to match those properties of the actually selected product Types.

8.1.13 Occupancy and As-Built Deliverable – As-Installed Asset Type Properties

The Beneficial Occupancy and As-Built COBie deliverables shall update the attributes of all designed assets to match those properties of installed products.

8.2 Required HVAC System Assets

8.2.1 Chiller

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 4 Design – Minimum Chiller Schedule Headings

Heading	Typical Unit
Name	Chiller-TypeXX-Space#-01
Type	Chiller-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space.Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Capacity	kW
Water Flow	m ³ /hr
Ambient Temp	C
Pressure Drop	kPa
Entering Water Temp	C
Leaving Water Temp	C
Motor Controller	-
Unloading Steps	-
Chiller Media	-
Chiller Type	-
Refrigerant Type	-
Energy Efficiency Ratio (EER)	Btu/hr to kW
Integrated Part-Load Value (IPLV)	-
Heat Reclaim	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built In Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.2 Boiler

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 5 Design – Minimum Boiler Schedule Headings

Heading	Typical Unit
Name	Boiler-TypeXX-Space#-01
Type	Boiler-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Input Power	kW
Output Power	kW
Water Flow	m ³ /hr
Entering Water Temp	C
Leaving Water Temp	C
Vent Diameter	mm
Passes	-
Pressure Drop	kPa
Energy Source	-
Fuel Type	-
Output Media	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.3 Air Handling Units

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 6 Design – Minimum Air Handling Unit Schedule Headings

Heading	Typical Unit
Name	AHU-TypeXX-Space#-01
Type	AHU-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Fan Flow - Maximum	L/s
Fan Flow - Nominal	L/s
Fan Outside Flow	L/s
Fan Ext Pressure Drop	kPa
Fan Motor Power	kW
Fan Speed	RPM
Fan Sound Level	dB
Coil Flow	L/s
Coil Velocity	m/min
Coil Capacity	W
EnteringAirTempDB	C
EnteringAirTempWB	C
LeavingAirTempDB	C
LeavingAirTempWB	C
EnteringWater Temp	C
Leaving Water Temp	C
Chilled Water Rate	L/s
Runout Inlet Size	mm
Runout Outlet Size	mm
Coil Air Pressure Drop	Pa
Coil Water Pressure Drop	kPa
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.4 Fan coil units

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 7 Design – Minimum Fan Coil Unit Schedule Headings

Heading	Typical Unit
Name	FanCoil-TypeXX-Space#-01
Type	FanCoil-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Air Flow	L/s
Fan Speed	-
Exit Static Pressure	Pa
EnteringAirTempDB	C
EnteringAirTempWB	C
LeavingAirTempDB	C
LeavingAirTempWB	C
Total Capacity	kW
Sensible Capacity	kW
EnteringWater Temp	C
Leaving Water Temp	C
Chilled Water Flow	L/s
Cooling Coil Delta P	kPa
Cooling Rows	-
Fan Motor Power	kW
Phase	-
Cabinet Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.5 Filters

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Air Flow maximum was included in this table since it was found in a note associated with each filter. The efficiency rating identified in the table is too general and should be clarified as either NominalCountedEfficiency or NominalWeightedEfficiency.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 8 Design – Minimum Filter Schedule Headings

Heading	Typical Unit
Name	HVACFilter-TypeXX-Space#-01
Type	HVACFilter-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Length	mm
Width	mm
Height	mm
Air Flow - Maximum	L/s
Air Flow - Nominal	L/s
Nominal Pressure Drop	Pa
Efficiency Rating	%
Residence Time	Sec
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.2.6 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 9 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	HVACPump-TypeXX-Space#-01
Type	HVACPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Rated Flow	L/s
Churn Pressure	kPa
Controller Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.7 Fans

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 10 Design – Minimum Fan Schedule Headings

Heading	Typical Unit
Name	Fan-TypeXX-Space#-01
Type	Fan-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Service	-
Flow Rate	L/s
Pressure	Pa
Control Type	-
Interlock	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.8 Motors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 11 Design – Minimum Motor Schedule Headings

Heading	Typical Unit
Name	Motor-TypeXX-Space#-01
Type	Motor-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Phase	-
Efficiency	-
Drive	-
Drive Control Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.9 Compressors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 12 Design – Minimum Compressor Schedule Headings

Heading	Typical Unit
Name	Compressor-TypeXX-Space#-01
Type	Compressor-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Refrigerant Type	-
Capacity	%
Speed	RPM
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.10 Variable Air Volume boxes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 13 Design – Minimum VAV Box Schedule Headings

Heading	Typical Unit
Name	VAV-TypeXX-Space#-01
Type	VAV-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Inlet Size	mm
Air Flow – Minimum	L/s
Air Flow - Maximum	L/s
Pressure Drop	Pa
NC Level – Discharge	dB
NC Level - Radiated	dB
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.2.11 Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component’s space
- Name of COBie.Component must be uniquely created using the following rule
 - “Valve-”& COBie.SpaceName & “-” & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.2.12 Traps

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "Trap-" & COBie.SpaceName & "-" & Item Count in Specific Space
- PM Schedules for this COBie.Type shall identify the frequency of inspection/maintenance required for this type of component.

8.2.13 Strainer

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "Strainer-" & COBie.SpaceName & "-" & Item Count in Specific Space
- PM Schedules for this COBie.Type shall identify the frequency of inspection/maintenance required for this type of component.

8.3 Required Plumbing System Assets

8.3.1 Water treatment Assemblies

Water treatment systems are an Assembly of three primary Component types that shall be included in COBie deliverables. These three Types are

- Pre-treatment equipment
- Potable water treatment equipment
- Pressure vessels

If a water treatment assembly is an internal part of a given facility then there shall be one Type object for “Water Treatment”.

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 14 Design – Minimum Water Treatment Assemblies Schedule Headings

Heading	Typical Unit
Name	WaterTreatmentAssembly-TypeXX-Space#-01
Type	WaterTreatmentAssembly-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
System Types	-
Water Softener	-
Disinfection Type	-
Rejection Ratio	-
Capacity	cu.meters/day
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.3.2 Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component’s space
- Name of COBie.Component must be uniquely created using the following rule
 - “Valve-”& COBie.SpaceName & “-“ & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.3.3 Plumbing Fixtures

While there are many different types of plumbing fixtures, they commonly use the same type of schedule, since each type of fixture performs a similar function. The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 15 Design – Minimum Plumbing Fixture Schedule Headings

Heading	Typical Unit
Name	PlumbingFixture-TypeXX-Space#-01
Type	PlumbingFixture-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Waste	WSFU
Vent	WSFU
Cold Water	WSFU
Hot Water	WSFU
Sanitary Fixture Water	liter/flush
Maximum Flow Rate	L/min
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.4 Required Fire Suppression System Assets

8.4.1 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 16 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	FireSupressionPump-TypeXX-Space#-01
Type	FireSupressionPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Rated Flow	L/s
Churn Pressure	kPa
Controller Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.4.2 Valves

Schedules for this type of device are not required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "Valve-" & COBie.SpaceName & "-" & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.4.3 Sprinkler heads

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. As a result Design Deliverables for this type of device shall be comprised of the following COBie information:

- One COBie.Type record for each type of component
- One COBie.Attribute record for each Type
 - Head Type
- One COBie.Component for each individual component, identifying the component's space.

At Beneficial Occupancy and As-Built deliverables, design schedules shall be updated as noted below.

- One COBie.Type record for each type of component
- Two COBie.Attribute record for each Type
 - Head Type
 - Thread Size
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "SprinklerHead-" & COBie.SpaceName & "-" & Item Count in Specific Space

8.4.4 Fire extinguishers

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable.

Table 17 Construction – Minimum Fire Extinguisher Schedule Headings

Heading	Typical Unit
Name	FireExtinguisher-TypeXX-Space#-01
Type	FireExtinguisher-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Capacity	Kg
Rating	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.5 Required Electrical System Assets

8.5.1 Light fixtures

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component’s specific use in a system.

Table 18 Design – Minimum Light Fixture Type Schedule Headings

Heading	Typical Unit
Name	LightFixture-TypeXX-Space#-01
Type	LightFixture-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Lens Type	
Lamp Type	-
Mounting	-

Lamp Type	-
Lamp Count	Each
Lamp Power	W
Function	-
Light Path	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

At Beneficial Occupancy and As-Built deliverables, design schedules shall be updated as noted below.

- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute record for each individual component
 - ElectricalPanelName
 - ElectricalPanelCircuit
- Name of COBie.Component must be uniquely created using the following rule
 - "Outlet-" & COBie.SpaceName & "-" & Item Count in Specific Space

8.5.2 Outlets

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. As a result Design Deliverables for this type of device shall be comprised of the following COBie information:

- One COBie.Type record for each type of component
- Three COBie.Attribute record for each Type
 - Voltage
 - Current
 - Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute record for each individual component
 - ElectricalPanelName
 - ElectricalPanelCircuit

At Beneficial Occupancy and As-Built deliverables, design schedules shall be updated as noted below.

- One COBie.Type record for each type of component
- Three COBie.Attribute record for each Type
 - Voltage

- Current
- Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute record for each individual component
 - ElectricalPanelName
 - ElectricalPanelCircuit
- Name of COBie.Component must be uniquely created using the following rule
 - "Outlet-" & COBie.SpaceName & "-" & Item Count in Specific Space

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8.5.3 Switches

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. As a result Design Deliverables for this type of device shall be comprised of the following COBie information:

- One COBie.Type record for each type of component
- Three COBie.Attribute record for each Type
 - Voltage
 - Current
 - Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute record for each individual component
 - ElectricalPanelName
 - ElectricalPanelCircuit

- At Beneficial Occupancy and As-Built deliverables, design schedules shall be updated as noted below.
- One COBie.Type record for each type of component
- Two COBie.Attribute record for each Type
 - Voltage
 - Current
 - Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute record for each individual component
 - ElectricalPanelName
 - ElectricalPanelCircuit

- Name of COBie.Component must be uniquely created using the following rule
 - "Switch-" & COBie.SpaceName & "-" & Item Count in Specific Space
- One COBie.Connection record for each fixture, outlet, or equipment controlled by this component.

8.5.4 Distribution panel

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 19 Design – Minimum Distribution Panel Type Schedule Headings

Heading	Typical Unit
Name	DistributionPanel-TypeXX-Space#-01
Type	DistributionPanel-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Phase	-
Number of Wires	-
Number of Poles	-
Main Breaker Mounting	-
Main Bus Current	Amps
Neutral Bus	-
Equip Ground Bus	-
Isolated Ground Bus	-
Mounting	-
AIC Rating	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

Note that the full specification of the electrical system may be developed through use of the COBie.Connection and COBie.Assembly worksheets. Unless specified by client, use of these worksheets is not required to meet the generic COBie Guide.

8.5.5 Switchgear

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 20 Design – Minimum Switchgear Type Schedule Headings

Heading	Typical Unit
Name	Switchgear-TypeXX-Space#-01
Type	Switchgear-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Operating Weight	Kg
Type of Support	-
Horizontal Bus Current	Amps
Vertical Bus Current	Amps
Short Circuit Interrupting Rating	KAIC
Enclosure Rating	-
Minimum Bus Bracing	KAIC
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.5.6 Generator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 21 Design – Minimum Generator Type Schedule Headings

Heading	Typical Unit
Name	Generator-TypeXX-Space#-01
Type	Generator-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Operating Weight	Kg
Type of Support	-
Maximum Power Output	kW
Fuel Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.6 Required Control System Assets

8.6.1 Sensors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 22 Design – Minimum Sensors Type Schedule Headings

Heading	Typical Unit
Name	Sensor-TypeXX-Space#-01
Type	Sensor-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Mounting	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.6.2 Controllers

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables. .

Note that the expected naming of this component should reflect the type and component’s specific use in a system.

Table 23 Design – Minimum Controller Type Schedule Headings

Heading	Typical Unit
Name	Controller-TypeXX-Space#-01
Type	Controller-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Mounting	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

Controllers will also be identified with one more attribute to allow operators to determine the primary component that is controlled by this device.

- ControlledDevice

8.7 Required Elevator System Assets

8.7.1 Elevator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables. .

Note that the expected naming of this component should reflect the type and component's specific use in a system.

Table 24 Design – Minimum Elevator Type Schedule Headings

Heading	Typical Unit
Name	Elevator-TypeXX-Space#-01
Type	Elevator-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Capacity	Kg
Speed	m/s
SCR HP Rating	-
MG Motor Power	KW
Starting Amps	Amps
Accelerating Amps	Amps
Mach. RM	K Cal/hr
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8 Required Food Service System Assets

8.8.1 Sinks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 25 Design – Minimum Sinks Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceSink-TypeXX-Space#-01
Type	FoodServiceSink-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Water Inlet	-
Drain	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.8.2 Waste Disposer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 26 Design – Minimum Waste Disposer Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceWasteDisposer-TypeXX-Space#-01
Type	FoodServiceWasteDisposer-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Water Inlet	-
Drain	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attribute:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.3 Dishwasher

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 27 Design – Minimum Dishwasher Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceDishwasher-TypeXX-Space#-01
Type	FoodServiceDishwasher-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Water Inlet	-
Drain	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.4 Refrigerator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 28 Design – Minimum Refrigerator Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceRefrigerator-TypeXX-Space#-01
Type	FoodServiceRefrigerator-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Water Inlet	-
Drain	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.5 Icemaker

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 29 Design – Minimum Icemaker Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceIcemaker-TypeXX-Space#-01
Type	FoodServiceIcemaker-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Water Inlet	-
Drain	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.6 Range

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 30 Design – Minimum Range Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceRange-TypeXX-Space#-01
Type	FoodServiceRange-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Gas	Mbtu
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.7 Fryer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 31 Design – Minimum Fryer Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceFryer-TypeXX-Space#-01
Type	FoodServiceFryer-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
Gas	Mbtu
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Note that the expected naming of this component should reflect the type and component’s specific use in this system.

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.8.8 Freezer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 32 Design – Minimum Freezer Type Schedule Headings

Heading	Typical Unit
Name	FoodServiceFreezer-TypeXX-Space#-01
Type	FoodServiceFreezer-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Connection	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.9 Required Architectural Assets

8.9.1 Doors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that a comma separated list of two space names is required for interior doors. The first space listed (or if only one space is provided) shall be the space into which the door opens.

Table 33 Design – Minimum Door Type Schedule Headings

Heading	Typical Unit
Name	Door-TypeXX-Space#-01
Type	Door-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Names)
Door Width	mm
Door Height	mm
Door Thickness	mm
Door Type	-
Door Material	-
Door Finish	-
Glazing Type	-
Security Code	-
Frame Type	-
Frame Material	-
Frame Finish	-
Frame Head	-
Frame Jam	-
Frame Sill	-
Fire Label Class	-
Fire Label Rating	-
Hardware Set	-
Pressurization	-
Egress Door	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.9.2 Windows

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that a comma separated list of two space names is required for interior windows.

Table 34 Design – Minimum Window Type Schedule Headings

Heading	Typical Unit
Name	Window-TypeXX-Space#-01
Type	Window-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Names)
Window Number	-
Security Code	-
Window Rating	-
Glazing Type	-
Window Size	-
Window Size	-
Window Size	-
Window Operation	-
Frame Material	-
U-Factor	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.9.3 Finishes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 35 Design – Minimum Finish Schedule Headings

Heading	Typical Unit
Name	-
Type	-
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Floor	-
Base	-
Walls	-
Ceiling Type	-
Ceiling Finish	-
Ceiling Height	mm
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.10 Furnishing Assets

While there are many different types of furnishing assets, they commonly use the same type of schedule. The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Table 36 Design – Minimum Furnishing Assets Schedule Headings

Heading	Typical Unit
Name	FurnishingAsset-TypeXX-Space#-01
Type	FurnishingAsset-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
GFCI	-
GFGI	-
CFCI	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11 Site Assets

8.11.1 Site Water Distribution System

8.11.1.1 Site Water Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 37 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	SiteWaterPump-TypeXX-Space#-01
Type	SiteWaterPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Flow Rate Min	L/s
Flow Rate Max	L/s
Pressure Head	kPa
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.11.1.2 Site Water Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component’s space
- Name of COBie.Component must be uniquely created using the following rule
 - “Valve-”& COBie.SpaceName & “-“ & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.11.1.3 Site Water Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component’s specific use in this system.

Table 38 Design – Minimum Tanks Schedule Headings

Heading	Typical Unit
Name	SiteWaterTank-TypeXX-Space#-01
Type	SiteWaterTank-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Access Type	-
Storage Type	-
Capacity	L
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11.2 Site Fire Suppression System

8.11.2.1 Fire Suppression Hydrants

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 39 Design – Minimum Hydrant Schedule Headings

Heading	Typical Unit
Name	Hydrant-TypeXX-Space#-01
Type	Hydrant-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Flow Rate	-
Pressure Rating	-
Body Color	-
Cap Color	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11.2.2 Fire Suppression Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "Valve-" & COBie.SpaceName & "-" & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.11.2.3 Fire Suppression Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 40 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	FirePump-TypeXX-Space#-01
Type	FirePump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Flow Rate Min	L/s
Flow Rate Max	L/s
Pressure Head	kPa
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.11.3 Water Supply Wells

8.11.3.1 Water Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 41 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	WaterSupplyPump-TypeXX-Space#-01
Type	WaterSupplyPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Power	kW
Flow Rate Min	L/s
Flow Rate Max	L/s
Pressure Head	kPa
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.11.3.2 Water Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component’s space
- Name of COBie.Component must be uniquely created using the following rule
 - “Valve-”& COBie.SpaceName & “-“ & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.11.4 Site Sanitary Sewer

8.11.4.1 Sewer Manholes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component’s specific use in this system.

Table 42 Design – Minimum Manhole Schedule Headings

Heading	Typical Unit
Name	SewerManhole-TypeXX-Space#-01
Type	SewerManhole-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
North Coordinate (Y)	-
East Coordinate (X)	-
Top	-
Inv. In	-
Inv. Out	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11.4.2 Sewer Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 43 Design – Minimum Pump Schedule Headings

Heading	Typical Unit
Name	SewerPump-TypeXX-Space#-01
Type	SewerPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Rated Flow	L/s
Churn Pressure	kPa
Controller Type	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.11.4.3 Sewer Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component's space
- Name of COBie.Component must be uniquely created using the following rule
 - "Valve-" & COBie.SpaceName & "-" & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)

- OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.11.4.4 Sewer Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 44 Design – Minimum Tank Schedule Headings

Heading	Typical Unit
Name	SewerTank-TypeXX-Space#-01
Type	SewerTank-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Access Type	-
Storage Type	-
Capacity	L
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11.5 Fuel Distribution

8.11.5.1 Fuel Distribution Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component's specific use in this system.

Table 45 Design – Minimum Fuel Pump Schedule Headings

Heading	Typical Unit
Name	FuelPump-TypeXX-Space#-01
Type	FuelPump-TypeXX
SpecificationSection	(as identified in client's contract)
Location	(Space Name)
Current	Amps
Voltage	Volts
Frequency	Hz
Service	-
Flow Rate Min	L/s
Flow Rate Max	L/s
Total Head	m
Rotation Speed	RPM
Power	kW
Phase	-
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section. In addition, the Beneficial Occupancy and As-Built Deliverables shall provide the following additional attributes:

- ElectricalPanelName
- ElectricalPanelCircuit

8.11.5.2 Fuel Distribution Valves

Schedules for this type of device are **not** required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

- One COBie.Type record for each type of component
- One COBie.Component for each individual component, identifying the component’s space
- Name of COBie.Component must be uniquely created using the following rule
 - “Valve-”& COBie.SpaceName & “-“ & Item Count in Specific Space
- Two COBie.Attribute record for each component
 - OperatingPositionNormal (open/closed)
 - OperatingPositionEmergency (open/closed)
- One COBie.Connection record for each component whose flow is controlled by this device.

8.11.5.3 Fuel Distribution Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable and subsequent construction deliverables.

Note that the expected naming of this component should reflect the type and component’s specific use in this system.

Table 46 Design – Minimum Fuel Tank Schedule Headings

Heading	Typical Unit
Name	FuelTank-TypeXX-Space#-01
Type	FuelTank-TypeXX
SpecificationSection	(as identified in client’s contract)
Location	(Space Name)
Access Type	-
Service	-
Fuel Type	-
Capacity	L
Dry Weight	Kg
Wet Weight	Kg
SpatialPlacement	(from approved list of placement types)
BasisOfDesign-Manufacturer	(If found on drawing schedules)
BasisOfDesign-ModelNumber	(If found on drawing schedules)
BasisOfDesign-Notes	(If found on drawing schedules)

Construction deliverables will be updated to reflect installed equipment and other information described in the General Requirements Section.

8.11.5.4 Fuel Distribution Switches

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. As a result Design Deliverables for this type of device shall be comprised of the following COBie information:

- One COBie.Type record for each type of component
- Three COBie.Attribute record for each Type
 - Voltage
 - Current
 - Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute for each individual component
 - PanelBoard
 - Circuit

At Beneficial Occupancy and As-Built deliverables, design schedules shall be updated as noted below.

- One COBie.Type record for each type of component
- Three COBie.Attribute record for each Type
 - Voltage
 - Current
 - Frequency
- One COBie.Component for each individual component, identifying the component's space
- Two COBie.Attribute for each individual component
 - PanelBoard
 - Circuit
- Name of COBie.Component must be uniquely created using the following rule
 - "Switch-" & COBie.SpaceName & "-" & Item Count in Specific Space
- One COBie.Connection record for each fixture, outlet, or equipment controlled by this component.

9 PARTS & CONSUMABLES

The following types of parts are to be identified:

1. General consumables
2. General custodial
3. General shop equipment
4. Equipment
5. Tools
6. Equipment specific materials

9.1 Common Facility Consumables

The following minimum set of information shall be provided in the Beneficial Occupancy Construction COBie Deliverable and reflected in the As-Built Construction Deliverable.

Table 47 Minimum Attributes for Common Facility Consumables and COBie Mapping

Heading	COBie Mapping				
	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Part Number	Spare	PartNumber		IfcIdentifier	
Description	Spare	Description		IfcText	
Vendor	Spare	Suppliers		IfcText	
Unit Price	Attribute	-	UnitPrice	IfcMonetaryUnit	Spare
Unit	Attribute	-	UnitOfMeasure	IfcUnit	Spare
Quantity	Attribute	-	Quantity	IfcCountMeasure	Spare
Material Cost	Attribute	-	MaterialCost	IfcMonetaryUnit	Spare
Shipping Cost	Attribute	-	ShippingCost	IfcMonetaryUnit	Spare
Sub Cost	Attribute	-	SubCost	IfcMonetaryUnit	Spare
Logistics Category 1	Attribute	-	LogisticsCategory1	IfcText	Spare
Logistics Category 2	Attribute	-	LogisticsCategory2	IfcText	Spare
Website	Attribute	-	Website	IfcText	Spare
Criticality	Attribute	-	Criticality	IfcText	Spare

9.2 Equipment Specific Consumables

The following minimum set of information shall be provided in the Beneficial Occupancy Construction COBie Deliverable and reflected in the As-Built Construction Deliverable.

Table 48 Minimum Attributes for Equipment Specific Consumables and COBie Mapping

Heading	COBie Mapping				
	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Part Number	Spare	PartNumber		IfcIdentifier	
Description	Spare	Description		IfcText	
Vendor	Spare	Suppliers		IfcText	
Spec Number	Attribute	-	SpecificationNumber	IfcLabel	Spare
Spec Section	Attribute	-	SpecificationSection	IfcLabel	Spare
Unit Price	Attribute	-	UnitPrice	IfcMonetaryUnit	Spare
Unit	Attribute	-	UnitOfMeasure	IfcUnit	Spare
Initial Order Quantity	Attribute	-	InitialOrderQuantity	IfcCountMeasure	Spare
Re-Order Quantity	Attribute	-	Re-OrderQuantity	IfcCountMeasure	Spare
Minimum Inventory Level	Attribute	-	MinimumInventoryLevel	IfcCountMeasure	Spare
Attic	Attribute	-	Attic	IfcText	Spare
Material Cost	Attribute	-	MaterialCost	IfcMonetaryUnit	Spare
Shipping Cost	Attribute	-	ShippingCost	IfcMonetaryUnit	Spare
Sub Cost	Attribute	-	SubCost	IfcMonetaryUnit	Spare
Logistics Category 1	Attribute	-	LogisticsCategory1	IfcText	Spare
Logistics Category 2	Attribute	-	LogisticsCategory2	IfcText	Spare
Website	Attribute	-	Website	IfcText	Spare
Criticality	Attribute	-	Criticality	IfcText	Spare

APPENDIX A - OWNER'S REQUIREMENTS

NOTE: Prior to the use of this document by a specific owner. This section should be updated to reflect the individual procedures and technologies in place by that owner to facilitate the production and delivery of COBie deliverables.

This Appendix provides the requirements for your specific Agency as additions to, or clarification of, the general requirements for COBie deliverables identified in the previous sections.

1 Automated Tools

It is recommended that the Agency utilizing this guide identify the necessary automated tools to be used during the different project phases.

Design

The Agency will need tools to capture the design information required in COBie. There are several design tools available to produce a design COBie file. More information related to such tools can be found on the COBie Means and Method page¹⁴.

Construction

The Agency will need tools to capture information during construction that is required in COBie. Tools can be used to capture assets' serial numbers or to electronically produce and transmit submittals. There are several tools available to accomplish this. More information can be found on the COBie Means and Method page¹⁵.

Commissioning

The Agency will need tools to capture and update information during the commissioning phase. There are several available tools to aid in this process. More information related to such tools can be found on the COBie Means and Method page¹⁶.

2 Mandatory Classification

In lieu of the client providing a specific classification scheme, the project team shall submit, to the owner for approval, the classification scheme to be used. The identification of the COBie.Sheet.Classification column data shall be a single text string with the Classification Number, a delimiter (typically a colon), and the Classification name, e.g. "11-12 11 34 00 : New Facility". The best

¹⁴ <http://www.buildingsmartalliance.org/index.php/projects/cobie>

¹⁵ <http://www.buildingsmartalliance.org/index.php/projects/cobie>

¹⁶ <http://www.buildingsmartalliance.org/index.php/projects/cobie>

classification found shall be used. If there is not a specifically applicable sub-classification, the higher level classification shall be selected. Spaces may be added to classification records to provide readability.

COBie.Contact Classification

The required classification to be used for COBie.Contact records identifies the organization's roles. The Agency specific table for contact classification shall be inserted in this section. If no specific agency table is available for this classification, OmniClass Table 34 – Organizational Roles shall be use as default.

COBie.Facility Classification

The required classification to be used for COBie.Facility records identifies the facility's function. The Agency specific table for facility classification shall be inserted in this section. If no specific agency table is available for this classification, OmniClass Table 11 - Construction Entities by Function shall be use as default.

COBie.Space Classification

The required classification to be used for COBie.Space records identifies the space's function. The Agency specific table for space classification shall be inserted in this section. If no specific agency table is available for this classification, OmniClass Table 13-Spaces by Function shall be use as default.

COBie.Zone Classification

The following zones are recommended to be included in COBie models, if such zones are relevant in the specific facility being modeled. These are provided in alphabetical order.

- Circulation Zone
- Fire Alarm Zone
- Historical Preservation Zone
- Lighting Zone
- Occupancy Zone
- Ventilation Zone

COBie.Type Classification

The required classification to be used for COBie.Type records identifies the asset type. The Agency specific table for type classification shall be inserted in this section. If no specific agency table is available for this classification, OmniClass Table 23-Products shall be use as default.

COBie.System Classification

The required classification to be used for COBie.System records identifies the system type. The Agency specific table for type classification shall be inserted in this section. If no specific agency table is available for this classification, OmniClass Table 21-Elements shall be use as default.

APPENDIX B – MAPPING FOR EQUIPMENT / ASSET SCHEDULE REQUIREMENTS

1 Required HVAC System Assets

1.1 Chiller

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Chiller_AIRCOOLED_UStypeProduct¹⁷

Table 49 Mapping for Minimum Chiller Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Chiller-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Chiller-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	kW	Attribute	-	NominalPower	IfcPowerMeasure	Type/Component
Capacity	kW	Attribute	-	NominalCapacity	IfcPowerMeasure	Type/Component
Water Flow	m ³ /hr	Attribute	-	NominalFlowRate	IfcVolumetricFlowRateMeasure	Type/Component
Ambient Temp	C	Attribute	-	AmbientTemperature	IfcThermodynamicTemperatureMeasure	Type/Component
Pressure Drop	kPa	Attribute	-	PressureDrop	IfcPressureMeasure	Type/Component
Entering Water Temp	C	Attribute	-	WaterTempEntering	IfcThermodynamicTemperatureMeasure	Type/Component
Leaving Water	C	Attribute	-	WaterTempLeaving	IfcThermodynamicTemperatureMeasure	Type/Component

¹⁷ http://www.wbdg.org/references/spie/111201/Chiller_AIRCOOLED_US/Chiller_AIRCOOLED_UStypeProduct.html

Temp				g	icTemperatureMeasure	
Motor Controller	-	Attribute	-	MotorController	IfcIdentifier	Type/Component
Unloading Steps	-	Attribute	-	UnloadingSteps	IfcText	Type/Component
Chiller Media	-	Attribute	-	ChillerMedia	IfcText	Type/Component
Chiller Type	-	Attribute	-	ChillerType	IfcText	Type/Component
Refrigerant Type	-	Attribute	-	RefrigerantType	IfcText	Type/Component
Energy Efficiency Ratio (EER)	Btu/hr to kW	Attribute	-	Energy Efficiency Ratio	IfcRatioMeasure	Type/Component
Integrated Part-Load Value (IPLV)	-	Attribute	-	Integrated Part-Load Value	IfcText	Type/Component
Heat Reclaim	-	Attribute	-	HeatReclaim	IfcBoolean	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

1.2 Boiler

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template Boiler_Steam_US¹⁸

Table 50 Mapping for Minimum Boiler Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Boiler-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Boiler-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type

¹⁸ http://www.wbdg.org/references/spie/110901/Boiler_STEAM_US/Boiler_STEAM_USTypeProduct.html

Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Input Power	kW	Attribute		PowerInput	IfcPowerMeasure	Type/Component
Output Power	kW	Attribute	-	PowerOutput	IfcPowerMeasure	Type/Component
Water Flow	m ³ /hr	Attribute	-	NominalFlowRate	IfcVolumetricFlowRateMeasure	Type/Component
Entering Water Temp	C	Attribute	-	WaterTempEntering	IfcThermodynamicTemperatureMeasure	Type/Component
Leaving Water Temp	C	Attribute	-	WaterTempLeaving	IfcThermodynamicTemperatureMeasure	Type/Component
Vent Diameter	mm	Attribute	-	VentDiameter	IfcPositiveLengthMeasure	Type/Component
Passes	-	Attribute	-	Passes	IfcText	Type/Component
Pressure Drop	kPa	Attribute	-	PressureDrop	IfcPressureMeasure	Type/Component
Energy Source	-	Attribute	-	EnergySource	IfcLabel	Type/Component
Fuel Type	-	Attribute	-	FuelType	IfcText	Type/Component
Output Media	-	Attribute	-	OutputMedia	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

1.3 Air Handling Units

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template UnitaryEquipment_AIRHANDLER_UStypeProduct¹⁹

Table 51 Mapping for Minimum Air Handling Unit Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	AHU-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	AHU-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Fan Flow - Maximum	L/s	Attribute	-	FanFlowRateMax	IfcVolumetricFlowRateMeasure	Type/Component
Fan Flow - Nominal	L/s	Attribute	-	FanFlowRateMin	IfcVolumetricFlowRateMeasure	Type/Component
Fan Outside Flow	L/s	Attribute	-	FanFlowRateOutside	IfcVolumetricFlowRateMeasure	Type/Component
Fan Ext Pressure Drop	kPa	Attribute	-	FanPressureDrop	IfcPressureMeasure	Type/Component
Fan Motor Power	kW	Attribute	-	FanMotorPower	IfcPowerMeasure	Type/Component
Fan Speed	RPM	Attribute	-	FanSpeed	IfcRotationalFrequencyMeasure	Type/Component
Fan Sound Level	dB	Attribute	-	FanSoundLevel	IfcSoundPressureMeasure	Type/Component
Coil Flow	L/s	Attribute	-	CoilFlow	IfcVolumetricFlowRateMeasure	Type/Component
Coil Velocity	m/min	Attribute	-	CoilVelocity	IfcLinearVelocityMeasure	Type/Component
Coil Capacity	W	Attribute	-	CoilCapacity	IfcPowerMeasure	Type/Component
EnteringAirTempDB	C	Attribute	-	EnteringAirTempDB	IfcThermodynamicTemperatureMeasure	Type/Component

¹⁹ http://www.wbdg.org/references/spie/111201/UnitaryEquipment_AIRHANDLER_US/UnitaryEquipment_AIRHANDLER_UStypeProduct.html

EnteringAirTempWB	C	Attribute	-	EnteringAirTempWB	IfcThermodynamicTemperatureMeasure	Type/Component
LeavingAirTempDB	C	Attribute	-	LeavingAirTempDB	IfcThermodynamicTemperatureMeasure	Type/Component
LeavingAirTempWB	C	Attribute	-	LeavingAirTempWB	IfcThermodynamicTemperatureMeasure	Type/Component
EnteringWaterTemp	C	Attribute	-	EnteringWaterTemp	IfcThermodynamicTemperatureMeasure	Type/Component
LeavingWaterTemp	C	Attribute	-	LeavingWaterTemp	IfcThermodynamicTemperatureMeasure	Type/Component
ChilledWaterRate	L/s	Attribute	-	ChilledWaterRate	IfcVolumetricFlowRateMeasure	Type/Component
RunoutInletSize	mm	Attribute	-	RunoutInletSize	IfcPositiveLengthMeasure	Type/Component
RunoutOutletSize	mm	Attribute	-	RunoutOutletSize	IfcPositiveLengthMeasure	Type/Component
CoilAirPressureDrop	Pa	Attribute	-	PressureDropCoilAir	IfcPressureMeasure	Type/Component
CoilWaterPressureDrop	kPa	Attribute	-	PressureDropCoilWater	IfcPressureMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

1.4 Fan coil units

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Coil_NOTDEFINED_US²⁰.

Table 52 Mapping for Minimum Fan Coil Unit Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	FanCoil-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	FanCoil-TypeXX	Component	TypeName		IfcText	

²⁰ http://www.wbdg.org/references/spie/110901/Coil_NOTDEFINED_US/Coil_NOTDEFINED_USTypeProduct.html

SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Air Flow	L/s	Attribute	-	NominalAirFlowRate	IfcVolumetricFlowRateMeasure	Type/Component
Fan Speed	-	Attribute	-	FanSpeed	IfcRotationalFrequencyMeasure	Type/Component
Exit Static Pressure	Pa	Attribute	-	ExitStaticPressure	IfcPressureMeasure	Type/Component
EnteringAirTempDB	C	Attribute	-	EnteringAirTempDB	IfcThermodynamicTemperatureMeasure	Type/Component
EnteringAirTempWB	C	Attribute	-	EnteringAirTempWB	IfcThermodynamicTemperatureMeasure	Type/Component
LeavingAirTempDB	C	Attribute	-	LeavingAirTempDB	IfcThermodynamicTemperatureMeasure	Type/Component
LeavingAirTempWB	C	Attribute	-	LeavingAirTempWB	IfcThermodynamicTemperatureMeasure	Type/Component
Total Capacity	KW	Attribute	-	TotalCapacity	IfcPowerMeasure	Type/Component
Sensible Capacity	KW	Attribute	-	NominalSensibleCapacity	IfcPowerMeasure	Type/Component
EnteringWaterTemp	C	Attribute	-	EnteringWaterTemp	IfcThermodynamicTemperatureMeasure	Type/Component
Leaving Water Temp	C	Attribute	-	LeavingWaterTemp	IfcThermodynamicTemperatureMeasure	Type/Component
Chilled Water Flow	L/s	Attribute	-	ChilledWaterFlow	IfcVolumetricFlowRateMeasure	Type/Component
Cooling Coil Delta P	kPa	Attribute	-	CoolingCoilDeltaP	IfcPressureMeasure	Type/Component
Cooling Rows	-	Attribute	-	CoolingRows	IfcReal	Type/Component
Fan Motor Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Phase	-	Attribute	-	PhaseReference	IfcLabel	Type/Component
Cabinet Type	-	Attribute	-	CabinetType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component

BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

1.5 Filters

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template Filter_AIRPARTICLEFILTER_US²¹. Air Flow maximum was included in this table since it was found in a note associated with each filter. The efficiency rating identified in the table is too general and should be clarified as either NominalCountedEfficiency or NominalWeightedEfficiency.

Table 53 Mapping for Minimum Filter Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Filter-TypeXX- Space#-01	Component	Name		IfcLabel	
Type	Filter-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Length	mm	Attribute	-	NominalLength	IfcPositiveLength Measure	Type/Component
Width	mm	Attribute	-	NominalWidth	IfcPositiveLength Measure	Type/Component
Height	mm	Attribute	-	NominalHeight	IfcPositiveLength Measure	Type/Component
Air Flow - Maximum	L/s	Attribute	-	MaxFlowRate	IfcVolumetricFlo wRateMeasure	Type/Component
Air Flow - Nominal	L/s	Attribute	-	NominalFlowRat e	IfcVolumetricFlo wRateMeasure	Type/Component
Nominal Pressure Drop	Pa	Attribute	-	NominalPressure Drop	IfcPressureMeas ure	Type/Component
Efficiency Rating	%	Attribute	-	Efficiency	IfcReal	Type/Component
Residence Time	Sec	Attribute	-	ResidenceTime	IfcTimeMeasur e	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component

²¹ http://www.wbdg.org/references/spie/110901/Filter_AIRPARTICLEFILTER_US/Filter_AIRPARTICLEFILTER_USTypeProduct.html

BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

1.6 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_CIRCULATOR_US²².

Table 54 Mapping for Minimum Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Pump-TypeXX- Space#-01	Component	Name		IfcLabel	
Type	Pump-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	`	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Rated Flow	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Churn Pressure	kPa	Attribute	-	ChurnPressure	IfcPressureMeasure	Type/Component
Controller Type	-	Attribute	-	ControllerType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²² http://www.wbdg.org/references/spie/111201/Pump_CIRCULATOR_US/Pump_CIRCULATOR_USTypeProduct.html

1.7 Fans

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Fan_CENTRIFUGALAIRFOIL_US²³

Table 55 Mapping for Minimum Fan Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Fan-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Fan-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Service	-	Attribute	-	TypeOfService	IfcText	Type/Component
Flow Rate	L/s	Attribute	-	NominalAirFlowRate	IfcVolumetricFlowRateMeasure	Type/Component
Pressure	Pa	Attribute	-	NominalTotalPressure	IfcPowerMeasure	Type/Component
Control Type	-	Attribute	-	CapacityControlType	IfcLabel	Type/Component
Interlock	-	Attribute	-	Interlock	IfcText	Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²³ http://www.wbdg.org/references/spie/111201/Fan_CENTRIFUGALAIRFOIL_US/Fan_CENTRIFUGALAIRFOIL_UStypeProduct.html

1.8 Motors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricMotor_DC_US²⁴.

Table 56 Mapping for Minimum Motor Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Motor-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Motor-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Phase	-	Attribute	-	PhaseReference	IfcLabel	Type/Component
Efficiency	-	Attribute	-	ElectricMotorEfficiency	IfcPowerMeasure	Type/Component
Drive	-	Attribute	-	Drive	IfcLabel	Type/Component
Drive Control Type	-	Attribute	-	DriveControlType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²⁴ http://www.wbdg.org/references/spie/110901/ElectricMotor_DC_US/ElectricMotor_DC_USTypeProduct.html

1.9 Compressors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Compressor_RECIPROCATING_US²⁵.

Table 57 Mapping for Minimum Compressor Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Compressor-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Compressor-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Refrigerant Type	-	Attribute	-	RefrigerantClass	IfcMaterialDefinition	Type/Component
Capacity	%	Attribute	-	NominalCapacity	IfcPowerMeasure	Type/Component
Speed	RPM	Attribute	-	CompressorSpeed	IfcRotationalFrequencyMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²⁵http://www.wbdg.org/references/spie/110901/Compressor_RECIPROCATING_US/Compressor_RECIPROCATING_USTypeProduct.html

1.10 Variable Air Volume boxes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template AirTerminalBox_VARIABLEFLOWPRESSUREDEPENDANT_US²⁶

Table 58 Mapping for Minimum VAV Box Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	VAV-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	VAV-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Inlet Size	mm	Attribute	-	InletSize	IfcPositiveLengthMeasure	Type/Component
Air Flow – Minimum	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Air Flow - Maximum	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Pressure Drop	Pa	Attribute	-	PressureDrop	IfcPressureMeasure	Type/Component
NC Level – Discharge	dB	Attribute	-	NCLevelDischarge	IfcSoundPressureMeasure	Type/Component
NC Level - Radiated	dB	Attribute	-	NCLevelRadiated	IfcSoundPressureMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²⁶ http://www.wbdg.org/references/spie/110901/AirTerminalBox_VARIABLEFLOWPRESSUREDEPENDANT_US/AirTerminalBox_VARIABLEFLOWPRESSUREDEPENDANT_USTypeProduct.html

2 Required Plumbing System Assets

2.1 Water treatment Assemblies

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable.

Table 59 Mapping for Minimum Water Treatment Assemblies Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	WaterTreatmentAssembly-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	WaterTreatmentAssembly-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
System Types	-	Attribute	-	SystemsType	IfcText	Type/Component
Water Softener	-	Attribute	-	WaterSoftener	IfcBoolean	Type/Component
Disinfection Type	-	Attribute	-	DisinfectionType	IfcText	Type/Component
Rejection Ratio	-	Attribute	-	RejectionRatio	IfcRatioMeasure	Type/Component
Capacity	cu.meters/day	Attribute	-	Capacity	IfcVolumetricFlowRateMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

2.1 Plumbing Fixtures

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template SanitaryTerminal_WASHHANDBASIN_PlumbingFixtures_US²⁷, SanitaryTerminal_TOILETPAN_PlumbingFixtures_US²⁸, SanitaryTerminal_URINAL_PlumbingFixtures_US²⁹

Table 60 Mapping for Minimum Plumbing Fixture Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	PlumbingFixture-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	PlumbingFixture-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Waste	WSFU	Attribute	-	WasteWater	IfcVolumetricFlowRateMeasure	Type/Component
Vent	WSFU	Attribute	-	Vent	IfcVolumetricFlowRateMeasure	Type/Component
Cold Water	WSFU	Attribute	-	ColdWater	IfcVolumetricFlowRateMeasure	Type/Component
Hot Water	WSFU	Attribute	-	HotWater	IfcVolumetricFlowRateMeasure	Type/Component
Sanitary Fixture Water	liter/flush	Attribute	-	SanitaryFixtureWater	IfcReal	Type/Component
Maximum Flow Rate	L/min	Attribute	-	MaximumFlowRate	IfcVolumetricFlowRateMeasure	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

²⁷ http://www.wbdg.org/references/spie/110901/SanitaryTerminal_WASHHANDBASIN_PlumbingFixtures_US/SanitaryTerminal_WASHHANDBASIN_PlumbingFixtures_USTypeProduct.html

²⁸ http://www.wbdg.org/references/spie/111201/SanitaryTerminal_TOILETPAN_PlumbingFixtures_US/SanitaryTerminal_TOILETPAN_PlumbingFixtures_USTypeProduct.html

²⁹ http://www.wbdg.org/references/spie/111201/SanitaryTerminal_URINAL_PlumbingFixtures_US/SanitaryTerminal_URINAL_PlumbingFixtures_USTypeProduct.html

3 Required Fire Suppression System Assets

3.1 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_CIRCULATOR_US³⁰.

Table 61 Mapping for Minimum Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Pump-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Pump-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	`	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Rated Flow	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Churn Pressure	kPa	Attribute	-	ChurnPressure	IfcPressureMeasure	Type/Component
Controller Type	-	Attribute	-	ControllerType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁰ http://www.wbdg.org/references/spie/111201/Pump_CIRCULATOR_US/Pump_CIRCULATOR_UStypeProduct.html

3.2 Fire extinguishers

Design schedules for this type of device on design drawings only identify each type of component. The location of each component is typically identified by drawing note. As a result Design Deliverables for this type of device shall be comprised of the following COBie information:

- One COBie.Type record for each type of component
- Two COBie.Attribute record for each Type
 - Capacity (Kg)
 - Rating
- One COBie.Component for each individual component, identifying the component's space

Schedules for this type of device are not required for COBie Design Deliverables, but will be required for COBie Beneficial Occupancy and As-Built Models. These schedules will consist of the following parts.

Table 62 Mapping for Minimum Fire Extinguisher Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	FireExtinguisher-TypeXX-Space#-01	Component	Name		IfcLabel	-
Type	FireExtinguisher-TypeXX	Component	TypeName		IfcText	-
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	-
Capacity	Kg	Attribute	-	Capacity	IfcMassMeasure	Component
Rating	-	Attribute	-	Rating	IfcText	Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

4 Required Electrical System Assets

4.1 Light fixtures

The following minimum set of information shall be provided Construction Document stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template LightFixture_DIRECTIONSOURCE_LightFixture_US³¹

Table 63 Mapping for Minimum Light Fixture Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	LightFixture-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	LightFixture-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Lens Type		Attribute	-	LensType	IfcLabel	Type/Component
Lamp Type	-	Attribute	-	LampType	IfcLabel	Type/Component
Mounting	-	Attribute	-	LightFixtureMountingType	IfcLabel	Type/Component
Lamp Count	Each	Attribute	-	LampCount	IfcCountMeasure	Type/Component
Lamp Power	W	Attribute	-	LampPower	IfcPowerMeasure	Type/Component
Function	-	Attribute	-	Function	IfcText	Type/Component
Light Path	-	Attribute	-	LightPath	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³¹ http://www.wbdg.org/references/spie/111201/LightFixture_DIRECTIONSOURCE_LightFixture_US/LightFixture_DIRECTIONSOURCE_LightFixture_USTypeProduct.html

4.2 Distribution panel

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template

ElectricDistributionBoard_DISTRIBUTIONBOARD_DistributionPanel_US³².

Table 64 Mapping for Minimum Distribution Panel Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	DistributionPanel-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	DistributionPanel-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Phase	-	Attribute	-	PhaseReference	IfcLabel	Type/Component
Number of Wires	-	Attribute	-	NumberOfWires	IfcCountMeasure	Type/Component
Number of Poles	-	Attribute	-	NumberOfPoles	IfcInteger	Type/Component
Main Breaker Mounting	-	Attribute	-	MainBreakerMounting	IfcText	Type/Component
Main Bus Current	Amps	Attribute	-	BusCurrent	IfcElectricCurrentMeasure	Type/Component
Neutral Bus	-	Attribute	-	NeutralBus	IfcBoolean	Type/Component
Equip Ground Bus	-	Attribute	-	EquipGroundBus	IfcBoolean	Type/Component
Isolated Ground Bus	-	Attribute	-	IsolatedGroundBus	IfcBoolean	Type/Component
Mounting	-	Attribute	-	MountingType	IfcText	Type/Component
AIC Rating	-	Attribute	-	AICRating	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type

³²http://www.wbdg.org/references/spie/111201/ElectricDistributionBoard_DISTRIBUTIONBOARD_DistributionPanel_US/ElectricDistributionBoard_DISTRIBUTIONBOARD_DistributionPanel_USTypeProduct.html

BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type
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4.3 Switchgear

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable.

Table 65 Mapping for Minimum Switchgear Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Switchgear-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Switchgear-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Operating Weight	Kg	Attribute	-	OperatingWeight	IfcMassMeasure	Type/Component
Type of Support	-	Attribute	-	SupportType	IfcText	Type/Component
Horizontal Bus Current	Amps	Attribute	-	HorizontalBusCurrent	IfcElectricCurrentMeasure	Type/Component
Vertical Bus Current	Amps	Attribute	-	VerticalBusCurrent	IfcElectricCurrentMeasure	Type/Component
Short Circuit Interrupting Rating	KAIC	Attribute	-	ShortCircuitInterruptingRating	IfcElectricCurrentMeasure	Type/Component
Enclosure Rating	-	Attribute	-	EnclosureRating	IfcText	Type/Component
Minimum Bus Bracing	KAIC	Attribute	-	MinimumBusBracing	IfcElectricCurrentMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

4.4 Generator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricGenerator_STANDALONE_US³³

Table 66 Mapping for Minimum Generator Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Generator-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Generator-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Operating Weight	Kg	Attribute	-	OperatingWeight	IfcMassMeasure	Type/Component
Type of Support	-	Attribute	-	SupportType	IfcText	Type/Component
Maximum Power Output	KW	Attribute	-	MaximumPowerOutput	IfcPowerMeasure	Type/Component
Fuel Type	-	Attribute	-	FuelType	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³³http://www.wbdg.org/references/spie/110901/ElectricGenerator_STANDALONE_US/ElectricGenerator_STANDALONE_USTypeProduct.html

5 Required Control System Assets

5.1 Sensors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe templates Sensor_MOVEMENTSENSOR_US³⁴ and Sensor_LIGHTSENSOR_US³⁵.

Table 67 Mapping for Minimum Sensors Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Sensor-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Sensor-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Mounting	-	Attribute	-	Mounting	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁴http://www.wbdg.org/references/spie/110901/Sensor_MOVEMENTSENSOR_US/Sensor_MOVEMENTSENSOR_USTypeProduct.html

³⁵http://www.wbdg.org/references/spie/110901/Sensor_LIGHTSENSOR_US/Sensor_LIGHTSENSOR_USTypeProduct.html

5.2 Controllers

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Controller_PROGRAMMABLE_US³⁶.

Table 68 Mapping for Minimum Controller Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Controller-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Controller-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Mounting	-	Attribute	-	Mounting	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁶http://www.wbdg.org/references/spie/110901/Controller_PROGRAMMABLE_US/Controller_PROGRAMMABLE_USTypeProduct.html

6 Required Elevator System Assets

6.1 Elevator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template TransportElement_ELEVATOR_US³⁷.

Table 69 Mapping for Minimum Elevator Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Elevator-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Elevator-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Capacity	Kg	Attribute	-	Capacity	IfcMassMeasure	Type/Component
Speed	m/s	Attribute	-	Speed	IfcLinearVelocityMeasure	Type/Component
SCR HP Rating	-	Attribute	-	SCRHPRating	IfcText	Type/Component
MG Motor Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Starting Amps	Amps	Attribute	-	StartingAmps	IfcElectricCurrentMeasure	Type/Component
Accelerating Amps	Amps	Attribute	-	AcceleratingAmps	IfcElectricCurrentMeasure	Type/Component
Mach. RM	K Cal/hr	Attribute	-	MachRM	IfcPowerMeasure	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁷ http://www.wbdg.org/references/spie/110901/TransportElement_ELEVATOR_US/TransportElement_ELEVATOR_USTypeProduct.html

7 Required Food Service System Assets

7.1 Sinks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template SanitaryTerminal_SINK_PlumbingFixtures_US³⁸.

Table 70 Mapping for Minimum Sinks Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Sink-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Sink-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Water Inlet	-	Attribute	-	WaterInlet	IfcText	Type/Component
Drain	-	Attribute	-	Drain	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁸http://www.wbdg.org/references/spie/111201/SanitaryTerminal_SINK_PlumbingFixtures_US/SanitaryTerminal_SINK_PlumbingFixtures_USTypeProduct.html

7.2 Waste Disposer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_USERDEFINED_FoodServiceEquipment_US³⁹.

Table 71 Mapping for Minimum Waste Disposer Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	WasteDisposer-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	WasteDisposer-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	kW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Water Inlet	-	Attribute	-	WaterInlet	IfcText	Type/Component
Drain	-	Attribute	-	Drain	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

³⁹http://www.wbdg.org/references/spie/110901/ElectricAppliance_USERDEFINED_FoodserviceEquipment_US/ElectricAppliance_USERDEFINED_FoodserviceEquipment_USTypeProduct.html

7.3 Dishwasher

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_DISHWASHER_US⁴⁰.

Table 72 Mapping for Minimum Dishwasher Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Dishwasher-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Dishwasher-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Water Inlet	-	Attribute	-	WaterInlet	IfcText	Type/Component
Drain	-	Attribute	-	Drain	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴⁰http://www.wbdg.org/references/spie/110901/ElectricAppliance_DISHWASHER_US/ElectricAppliance_DISHWASHER_USTypeProduct.html

7.4 Refrigerator

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_REFRIGERATOR_US⁴¹.

Table 73 Mapping for Minimum Refrigerator Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Refrigerator-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Refrigerator-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Water Inlet	-	Attribute	-	WaterInlet	IfcText	Type/Component
Drain	-	Attribute	-	Drain	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴¹http://www.wbdg.org/references/spie/110901/ElectricAppliance_REFRIGERATOR_US/ElectricAppliance_REFRIGERATOR_USTypeProduct.html

7.5 Icemaker

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_USERDEFINED_FoodServiceEquipment_US⁴².

Table 74 Mapping for Minimum Icemaker Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Icemaker-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Icemaker-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Water Inlet	-	Attribute	-	WaterInlet	IfcText	Type/Component
Drain	-	Attribute	-	Drain	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴²http://www.wbdg.org/references/spie/110901/ElectricAppliance_USERDEFINED_FoodserviceEquipment_US/ElectricAppliance_USERDEFINED_FoodserviceEquipment_UStypeProduct.html

7.6 Range

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_ELECTRICCOOKER_US⁴³.

Table 75 Mapping for Minimum Range Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Range-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Range-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	kW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Gas	Mbtu	Attribute	-	Gas	IfcEnergyMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴³http://www.wbdg.org/references/spie/110901/ElectricAppliance_ELECTRICCOOKER_US/ElectricAppliance_ELECTRICCOOKER_USTypeProduct.html

7.7 Fryer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_ELECTRICCOOKER_US⁴⁴.

Table 76 Mapping for Minimum Fryer Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Fryer-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Fryer-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	KW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
Gas	Mbtu	Attribute	-	Gas	IfcEnergyMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴⁴http://www.wbdg.org/references/spie/110901/ElectricAppliance_ELECTRICCOOKER_US/ElectricAppliance_ELECTRICCOOKER_USTypeProduct.html

7.8 Freezer

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template ElectricAppliance_FREEZER_US⁴⁵.

Table 77 Mapping for Minimum Freezer Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Freezer-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Freezer-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Power	kW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Connection	-	Attribute	-	Connection	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴⁵http://www.wbdg.org/references/spie/110901/ElectricAppliance_FREEZER_US/ElectricAppliance_FREEZER_USTypeProduct.html

8 Required Architectural Assets

8.1 Doors

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Window Door_DOOR_SecurityDoorsandFrames_US⁴⁶

Table 78 Mapping for Minimum Door Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Door-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Door-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Door Width	mm	Type	NominalLength		IfcPositiveLengthMeasure	
Door Height	mm	Type	NominalHeight		IfcPositiveLengthMeasure	
Door Thickness	mm	Type	NominalThickness		IfcPositiveLengthMeasure	
Door Type	-	Type	Name		IfcLabel	
Door Material	-	Type	Material		IfcLabel	
Door Finish	-	Type	Finish		IfcText	
Glazing Type	-	Attribute	-	Glazing	IfcText	Type
Security Code	-	Attribute	-	SecurityCode	IfcText	Type
Frame Type	-	Attribute	-	FrameType	IfcText	Type/Component
Frame Material	-	Attribute	-	FrameMaterial	IfcText	Type/Component
Frame Finish	-	Attribute	-	FrameFinish	IfcText	Type/Component
Frame Head	-	Attribute	-	Head	IfcText	Type/Component
Frame Jam	-	Attribute	-	Jam	IfcText	Type/Component
Frame Sill	-	Attribute	-	Sill	IfcText	Type/Component
Fire Label Class	-	Attribute	-	Class	IfcLabel	Type

⁴⁶http://www.wbdg.org/references/spie/110901/Door_DOOR_SecurityDoorsandFrames_US/Door_DOOR_SecurityDoorsandFrames_USTypeProduct.html

Fire Label Rating	-	Attribute	-	FireRating	IfcLabel	Type
Hardware Set	-	Attribute	-	HardwareSet	IfcText	Type/Component
Pressurization	-	Attribute	-	Pressurization	IfcBoolean	Type/Component
Egress Door	-	Attribute	-	Egress	IfcBoolean	Type/Component
Spatial Placement	(From List)	Attribute	-		IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

8.2 Windows

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Window_WINDOW_SecurityWindows_US⁴⁷

Table 79 Mapping for Minimum Window Type Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Window-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Window-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Window Number	-	Attribute	-	Name	IfcIdentifier	Type
Security Code	-	Attribute	-	SecurityCode	IfcText	Type
Window Rating	-	Attribute	-	Rating	IfcText	Type
Glazing Type	-	Attribute	-	Glazing	IfcText	Type
Window Size	-	Type	NominalLength	NominalLength	IfcPositiveLength Measure	Type
Window Size	-	Type	NominalHeight	NominalHeight	IfcPositiveLength Measure	Type
Window Size	-	Type	NominalWidth	NominalThickness	IfcPositiveLength Measure	Type

⁴⁷http://www.wbdg.org/references/spie/110901/Window_WINDOW_SecurityWindows_US/Window_WINDOW_SecurityWindows_USTypeProduct.html

Window Operation	-	Attribute	-	WindowOperation	IfcText	Type/Component
Frame Material	-	Attribute	-	FrameMaterial	IfcText	Type/Component
U-Factor	-	Attribute	-	Ufactor	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

8.3 Finishes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable.

Table 80 Mapping for Minimum Finish Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	-					
Type	-					
Specification Section	-	Attribute	Type Name		IfcText	Type
Location	(Space Name)	Space	Name	-	IfcIdentifier	Space
Floor	-	Attribute	-	CoveringFloor	IfcLabel]	Space
Base	-	Attribute	-	CoveringBase	IfcLabel	Space
Walls	-	Attribute	-	CoveringWalls	IfcLabel	Space
Ceiling Type	-	Attribute	-	ConvergingCeilingType	IfcLabel	Space
Ceiling Finish	-	Attribute		CoveringCeilingFinish	IfcText	Space
Ceiling Height	mm	Attribute	-	CeilingHeight	IfcPositiveLengthMeasure	Space
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Space
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Space
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

9 Furnishing Assets

While there are many different types of furnishing assets, they commonly use the same type of schedule. The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie templates Furniture_SHELF_US⁴⁸ and Furniture_TABLE_US⁴⁹.

Table 81 Mapping for Minimum Furnishing Assets Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	FurnishingAsset-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	FurnishingAsset-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
GFCI	-	Attribute	-	GFCI	IfcBoolean	Type/Component
GFGI	-	Attribute	-	GFGI	IfcBoolean	Type/Component
CFCI	-	Attribute	-	CFCI	IfcBoolean	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁴⁸ http://www.wbdg.org/references/spie/110901/Furniture_SHELF_US/Furniture_SHELF_USTypeProduct.html

⁴⁹ http://www.wbdg.org/references/spie/110901/Furniture_TABLE_US/Furniture_TABLE_USTypeProduct.html

10 Site Assets

10.1 Site Water Distribution System

10.1.1 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_CIRCULATOR_US⁵⁰.

Table 82 Mapping for Minimum Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Pump-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Pump-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	`	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Rated Flow	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Churn Pressure	kPa	Attribute	-	ChurnPressure	IfcPressureMeasure	Type/Component
Controller Type	-	Attribute	-	ControllerType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁰http://www.wbdg.org/references/spie/111201/Pump_CIRCULATOR_US/Pump_CIRCULATOR_USTypeProduct.html

10.1.2 Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template Tank_STORAGE_US⁵¹.

Table 83 Mapping for Minimum Tanks Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Tank-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Tank-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Access Type	-	Attribute	-	AccessType	IfcLabel	Type/Component
Storage Type	-	Attribute	-	StorageType	IfcLabel	Type/Component
Capacity	L	Attribute	-	NominalCapacity	IfcVolumeMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵¹ http://www.wbdg.org/references/spie/110901/Tank_STORAGE_US/Tank_STORAGE_USTypeProduct.html

10.2 Site Fire Suppression System

10.2.1 Hydrants

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template FireSuppressionTerminal_FIREHYDRANT_US⁵².

Table 84 Mapping for Minimum Hydrant Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Hydrant-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Hydrant-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Flow Rate	-	Attribute	-	DischargeFlowRate	IfcVolumetricFlowRate Measure	Type/Component
Pressure Rating	-	Attribute	-	PressureRating	IfcPressureMeasure	Type/Component
Body Color	-	Attribute	-	BodyColor	IfcText	Type/Component
Cap Color	-	Attribute	-	CapColor	IfcText	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵²http://www.wbdg.org/references/spie/110901/FireSuppressionTerminal_FIREHYDRANT_US/FireSuppressionTerminal_FIREHYDRANT_USTypeProduct.html

10.3 Water Supply Wells

10.3.1 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_CIRCULATOR_US⁵³.

Table 85 Mapping for Minimum Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Pump-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Pump-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	`	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Rated Flow	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Churn Pressure	kPa	Attribute	-	ChurnPressure	IfcPressureMeasure	Type/Component
Controller Type	-	Attribute	-	ControllerType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵³http://www.wbdg.org/references/spie/111201/Pump_CIRCULATOR_US/Pump_CIRCULATOR_USTypeProduct.html

10.4 Site Sanitary Sewer

10.4.1 Manholes

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template DistributionChamberElement_MANHOLE_US⁵⁴.

Table 86 Mapping for Minimum Manhole Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Manhole-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Manhole-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
North Coordinate (Y)	-	Attribute	-	NorthCoordinate	IfcIdentifier	Type/Component
East Coordinate (X)	-	Attribute	-	EastCoordinate	IfcIdentifier	Type/Component
Top	-	Attribute	-	Top	IfcReal	Type/Component
Inv. In	-	Attribute	-	InvIn	IfcReal	Type/Component
Inv. Out	-	Attribute	-	InvOut	IfcReal	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁴http://www.wbdg.org/references/spie/110901/DistributionChamberElement_MANHOLE_US/DistributionChamberElement_MANHOLE_USTypeProduct.html

10.4.2 Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_CIRCULATOR_US⁵⁵.

Table 87 Mapping for Minimum Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Pump-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Pump-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	`	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Rated Flow	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Churn Pressure	kPa	Attribute	-	ChurnPressure	IfcPressureMeasure	Type/Component
Controller Type	-	Attribute	-	ControllerType	IfcText	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁵http://www.wbdg.org/references/spie/111201/Pump_CIRCULATOR_US/Pump_CIRCULATOR_USTypeProduct.html

10.4.3 Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template Tank_STORAGE_US⁵⁶.

Table 88 Mapping for Minimum Tank Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	Tank-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	Tank-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Access Type	-	Attribute	-	AccessType	IfcLabel	Type/Component
Storage Type	-	Attribute	-	StorageType	IfcLabel	Type/Component
Capacity	L	Attribute	-	NominalCapacity	IfcVolumeMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁶ http://www.wbdg.org/references/spie/110901/Tank_STORAGE_US/Tank_STORAGE_USTypeProduct.html

10.5 Fuel Distribution

10.5.1 Fuel Pumps

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPIe template Pump_SUBMERSIBLEPUMP_US⁵⁷.

Table 89 Mapping for Minimum Fuel Pump Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	FuelPump-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	FuelPump-TypeXX	Component	TypeName		IfcText	
Specification Section	-	Attribute	TypeName		IfcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Current	Amps	Attribute	-	Current	IfcElectricCurrentMeasure	Type/Component
Voltage	Volts	Attribute	-	Voltage	IfcElectricVoltageMeasure	Type/Component
Frequency	Hz	Attribute	-	Frequency	IfcFrequencyMeasure	Type/Component
Service	-	Attribute	-	Service	IfcText	Type/Component
Flow Rate Min	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Flow Rate Max	L/s	Attribute	-	FlowRateRange	IfcVolumetricFlowRateMeasure	Type/Component
Total Head	m	Attribute	-	TotalHead	IfcLengthMeasure	Type/Component
Rotation Speed	RPM	Attribute	-	NominalRotationSpeed	IfcRotationalFrequencyMeasure	Type/Component
Power	kW	Attribute	-	Power	IfcPowerMeasure	Type/Component
Phase	-	Attribute	-	PhaseReference	IfcLabel	Type/Component
Spatial Placement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign-Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign-ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign-Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁷ http://www.wbdg.org/references/spie/110901/Pump_SUBMERSIBLEPUMP_US/Pump_SUBMERSIBLEPUMP_US_TypeProduct.html

10.5.2 Fuel Tanks

The following minimum set of information shall be provided in Construction Documents stage design deliverable schedule and reflected in the CD Stage COBie Deliverable. COBie data mapping is based on COBie format and current SPie template Tank_STORAGE_US⁵⁸.

Table 90 Mapping for Minimum Fuel Tank Schedule Headings

Design Schedule		COBie Mapping				
Heading	Unit	Sheet	Column	Attribute Name	Data Type	Attribute Reference
Name	FuelTank-TypeXX-Space#-01	Component	Name		IfcLabel	
Type	FuelTank-TypeXX	Component	TypeName		IfcText	
SpecificationSection	-	Attribute	TypeName		ifcText	Type
Location	(Space Name)	Component	SpaceName		IfcIdentifier	
Access Type	-	Attribute	-	AccessType	IfcLabel	Type/Component
Service	-	Attribute	-	StorageType	IfcLabel	Type/Component
Fuel Type	-	Attribute	-	FuelType	IfcText	Type/Component
Capacity	L	Attribute	-	NominalCapacity	IfcVolumeMeasure	Type/Component
Dry Weight	Kg	Attribute	-	DryWeight	IfcMassMeasure	Type/Component
Wet Weight	Kg	Attribute	-	WetWeight	IfcMassMeasure	Type/Component
SpatialPlacement	(From List)	Attribute	-	Placement	IfcText	Component
BasisOfDesign- Manufacturer	(Basis of Design)	Attribute	-	BODManufacturer	IfcLabel	Type
BasisOfDesign- ModelNumber	(Basis of Design)	Attribute	-	BODModel	IfcLabel	Type
BasisOfDesign- Notes	(If Required)	Attribute	-	BODNotes	IfcText	Type

⁵⁸ http://www.wbdg.org/references/spie/110901/Tank_STORAGE_US/Tank_STORAGE_USTypeProduct.html