Daniel Cortez Data Centre Assessment

Data Centre Design Assessment - Part 2 – Project planning

These assessment tasks provide an opportunity for you to demonstrate the competencies required to plan for the provisioning of a data centre to meet operational and efficiency goals.

Successful completion of this assessment contributes towards attaining competency in the following:

ICTICT418	Contribute to copyright, ethics and privacy in an IT environment
ICTPMG610	Develop a project management plan
ICTSUS601	Integrate sustainability in ICT planning and design projects
ICTPMG611	Prepare a detailed design brief
ICTTEN611	Produce an ICT network architecture design
ICTNWK529	Install and manage complex ICT networks

Tasks

1. Produce a high level project plan for the design, implementation, commissioning of the data centre. *References - Schneider Electric - Data Center Projects, Schneider Electric, Schneider Electric - Reference Design 33, Schneider Electric - Data Centre commissioning*. The project plan should:

1.Show how you will integrate sustainability into the project
2.List all project tasks and timelines
3.Include resource requirements
4.Include a training plan detailing requirements - e.g. working with heritage sites or asbestos hazards
5.Include a budget
6.Include a commissioning audit document
7.Include work health and safety requirements
8.Include a gantt chart

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1.Show how you will integrate sustainability into the project

We propose five categories which include 23 key metrics for the data center operators who are in the Beginning, Advanced and Leading stages of their sustainability journey. We also identify the 17 most relevant sustainability frame-works and standards to guide data center operators in target setting, reporting and certifying.

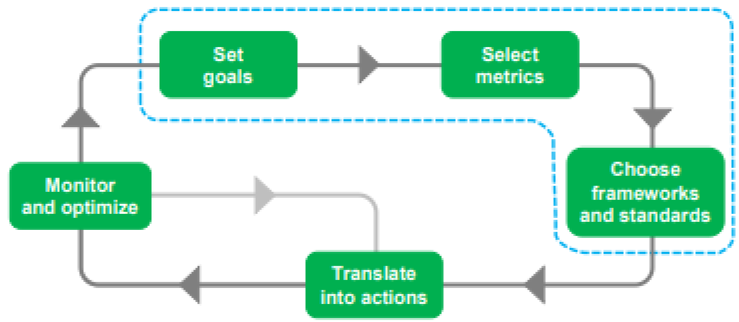

Figure 1: Steps to optimize a data center´s sustainability

We have identified 23 sustainability metrics that apply to a data center across five metric categories. These categories represent a holistic approach to addressing environmental sustainability: Energy, Greenhouse gases (GHG) emissions, water, waste, land and biodiversity.

_ **Energy:** According to some estimates, data center energy consumption represents 1-2 % of global energy use, the greatest resource used by data centers. The on-going rapid growth and projected future growth of data centers make energy consumption and efficiency an important focus in a data center´s sustainability journey. In addition to reducing consumption through efficient operations, the use of renewable energy helps reduce the greenhouse gases (GHG) emissions represented in electricity consumption.

_ **Greenhouse gases (GHG) emissions:** CO_2 and other gases such as CH_4, PFCs, HFCs are classified as greenhouse gases. These GHG emissions, also referred to as "carbon emissions", are a major contributor to climate change and one of the most pressing issues facing society today. Reporting GHG emissions is important for the data center operators to show their efforts on controlling climate change.

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_**Water:** Cooling towers and other evaporative cooling techniques are popular heat rejection solutions for data centers because of their high efficiency and large cooling capacity. Using reclaimed or recycled water instead of fresh water (potable water) helps reduce the pressure on local water resources. Reporting water usage is becoming more important for data center operators as a part of their overall sustainability goals.

_**Waste:** Data centers generate significant waste during construction and operations. Minimizing waste generation from the supply chain and diverting waste out of landfills through reuse and recycling is a key strategy for being more environmentally sustainable. Reporting waste generation and diversion is emerging in importance and likely to become commonplace in the near future.

_ Land & biodiversity: Data centers have a direct impact on the land they are built upon and an indirect land impact from their supply chain. Compared to the total area commercial office building use, data centers have a relatively small footprint. However, for data centers with dedicated solar/wind farms, the impact on land and biodiversity can be significant for individual organizations.

Beginning	Advanced	Leading
• Energy • GHG emissions • Water	• Energy • GHG emissions • Water • Waste	• Energy • GHG emissions • Water • Waste • Land & biodiversity

Table 1 is a summary of the five metric categories mapped to the three stages of sustainability journey

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Below we detail the metrics within each category, and how they map to the stages of development.

Metric categories	Key metrics	Units	Recommendations		
			Beginning (11)	Advanced (18)	Leading (23)
Energy (5)	• Total energy consumption	kWh	✓	✓	✓
	• Power usage effectiveness (PUE)	Ratio	✓	✓	✓
	• Total renewable energy consumption	kWh	✓	✓	✓
	• Renewable energy factor (REF)	Ratio		✓	✓
	• Energy Reuse Factor (ERF)	Ratio			✓
GHG emissions (9)	• GHG emissions: (Scope 1)	$mtCO_2e$	✓	✓	✓
	• Location-based GHG emissions: (Scope 2)	$mtCO_2e$	✓	✓	✓
	• Market-based GHG emissions: (Scope 2)	$mtCO_2e$	✓	✓	✓
	• GHG emissions: (Scope 3)	$mtCO_2e$			✓
	• Location-based carbon intensity (Scope 1+ Scope 2)	$mtCO_2e$/kWh	✓	✓	✓
	• Market-based carbon intensity (Scope 1+ Scope 2)	$mtCO_2e$/kWh	✓	✓	✓
	• Carbon usage effectiveness (CUE)	$mtCO_2e$/kWh	✓	✓	✓
	• Total carbon offsets	$mtCO_2e$		✓	✓
	• Hour-by-hour supply and consumption matching	TBD			✓
Water (4)	• Total site water usage	m^3	✓	✓	✓
	• Total source energy water usage	m^3		✓	✓
	• Water usage effectiveness (WUE)	m^3/kWh	✓	✓	✓
	• Total water use in supply chain	m^3			✓
Waste (4)	• Total waste generated	tons		✓	✓
	• Waste landfilled	tons		✓	✓
	• Waste diverted	tons		✓	✓
	• Waste diversion rate	Ratio		✓	✓
Land & biodiversity (1)	• Mean species abundance (MSA)	MSA/km^2			✓

$mtCO_2e$ = Metric tons of carbon dioxide equivalent

Table 2 details the 23 metrics and their recommended use according to the three stages of the journey.

23 metrics

Energy

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_*Total energy consumption:* In many cases, a significant portion of carbon emissions for data centers comes from energy consumption. Understanding the total energy consumption is necessary to track improvement in efficiency and reduce the carbon mix in the supply.

_*Power usage effectiveness (PUE):* PUE is an effective metric to drive facility efficiency during the design phase and while in operation. Normalized to the IT load. Although PUE is not a perfect metric, its simplicity has allowed data center operators to minimize the overhead energy use of the facility.

_ *Total renewable energy consumption:* Organizations can reduce their scope 2 carbon emissions by the consumption of renewable energy. Replacing fossil fuel-based energy with renewables from a low or zero carbon emissions source should be a key component of carbon neutral strategies for energy consumption

_ *Renewable energy factor (REF*): This is a normalized metric that allows comparisons across different data center sizes. It is also enables operators to track their renewable energy consumption as the data center load changes.

_ *Energy reuse factor (ERF*): The purpose of this metric is to push data center operators and municipalities to find ways to re-purpose waste heat.

GHG emissions

_*GHG emissions (scope1):* Reporting on and tracking Scope 1 GHG emissions helps data center make operational improvements to reduce this impact. During the design phase of the facility, Scope 1 emissions should be considered and solutions to reduce or eliminate this source should be implemented.

_*Location-based and market-based GHG emissions (Scope 2):* These two metrics are used to measure the indirect emissions from purchased or acquired electricity, steam, heat, and cooling that are controlled or owned by a data center organization. The location-based metric can be used to described the GHG intensity of grids and assess risks/opportunities aligned with local grid resources and emissions. The metric-based metric describes the organization procurement actions and assesses risk/opportunities with contractual electricity procurement.

_*GHG emissions (scope3):* Calculating and reporting on scope 3 is a leading metric

_*Location-based and market-based carbon intensity (scope 1 + Scope 2): This* metric is a ratio and allows for comparisons across data centers and even other industries. It can be used in the site selection, planning and design phase, as well as operations to measure effectiveness of continuous improvement programs.

_*Carbon usage effectiveness (CUE): Similar* to carbon intensity, this metric allows comparisons of carbon emission across data centers and other industries.

_*Total carbon offsets:* This metric can be used to quantify the purchased carbon offsets to address Scope 1 and Scope 3 carbon emissions that are not mitigated or avoided. It provided reporting transparency and visibility into true carbon reduction efforts vs purchased offsets.

_ *Hour-by-hour supply and consumption matching:* This can provide a higher level of transparency into how renewable energy production matches consumption in real time. The goal is to reach 100% match of renewable production and consumption on an hour-by-hour basis.

Water

_*Total site water usage:* This metric is used to report the direct water usage by a data center, similar to Scope 1 GHG emissions. Predicting water use in the design phase will result in improved cooling technology that reduces site water usage.

_ *Total source energy water usage:* Similar to Scope 2 GHG emissions, this metric can be used to illustrate the indirect water a data center organization uses. Data center operators can use this metric as an approach to optimize the water use related with energy consumption. Understanding water use at the site and energy source gives a holistic view to minimize the total water usage.

_ *Water usage effectiveness (WUE):* WUE allows for comparisons across different size data centers and should be considered during the planning and design phases and uses during operations to track continued reduction in water use.

_ *Total water use in supply chain:* This is a concept under development and is analogous to Scope 3 emissions. This metric could track the water consumed in the value chain, which supplies material, equipment, and services to a data center.

Waste

_*Total waste generated:* This metric can be used to quantify the organization´s waste-related impacts on the environment and the target is to minimize overall waste generated. Direct waste should be the focus of reporting, and as reporting improves throughout the industry, indirect waste generation can be added to track the supply chain.

_*Waste landfilled:* This metric is used to track waste to landfills and help create programs to reduce the amount.

_ *Waste diversion rate:* This metric creates a ratio that can be compared across data centers. It is useful for benchmarking and creating meaningful improvement programs to drive this towards 100%.

Land & biodiversity

_*Mean species abundance (MSA):* CDC Biodiversite developed this metric as a biodiversity footprint methodology with the objective of creating a global biodiversity score (GBS). This metric measures a data center´s impact on biodiversity. This is not yet a standard.

The table below simplifies the complexity of the many frameworks available by mapping the metrics to the most relevant frameworks and standards.

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Table 4
Matrix between 23 key metrics, frameworks, and standards.

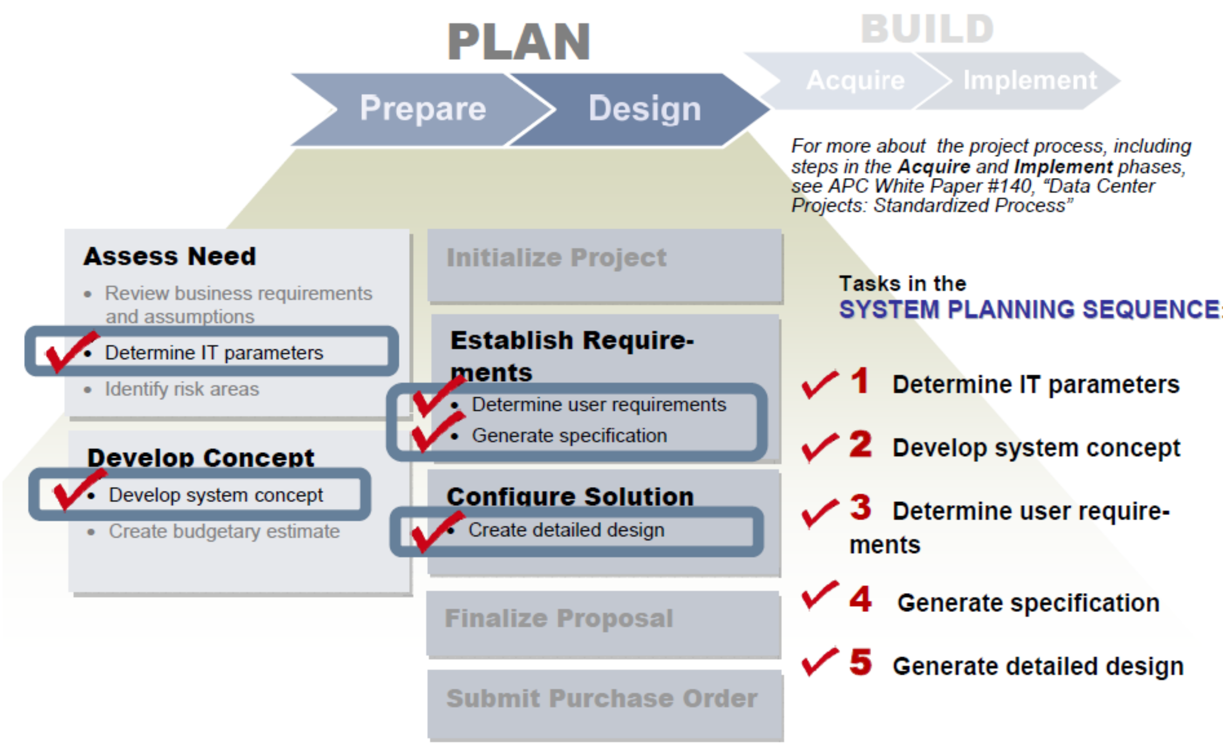
Metric categories	Key metrics	Recommended frameworks/standards
Energy (5)	Total energy consumption	SASB
	Power usage effectiveness (PUE)	ISO/IEC 30134-2
	Total renewable energy consumption	RE100
	Renewable energy factor (REF)	ISO/IEC 30134-3
	Energy Reuse Factor (ERF)	ISO/IEC 30134-6
GHG emissions (9)	GHG emissions: (Scope 1)	GHG Protocol or ISO 14064
	Location-based GHG emissions: (Scope 2)	GHG Protocol or ISO 14064
	Market-based GHG emissions: (Scope 2)	GHG Protocol or ISO 14064
	GHG emissions: (Scope 3)	GHG Protocol or ISO 14064
	Location-based carbon intensity (Scope 1+ Scope 2)	GHG Protocol or ISO 14064
	Market-based carbon intensity (Scope 1+ Scope 2)	GHG Protocol or ISO 14064
	Carbon usage effectiveness (CUE)	ISO/IEC 30134-8
	Total carbon offsets	N/A, see a White Paper on this topic.
	Hour-by-hour supply and consumption matching	No frameworks or standards available
Water (4)	Total site water usage	ISO/IEC 30134-9
	Total source energy water usage	No frameworks or standards available
	Water usage effectiveness (WUE)	ISO/IEC 30134-9
	Total water use in supply chain	No frameworks or standards available
Waste (4)	Total waste generated	GRI 300: Environmental - 306
	Waste landfilled	GRI 300: Environmental - 306
	Waste diverted	GRI 300: Environmental - 306
	Waste diversion rate	GRI 300: Environmental - 306
Land & biodiversity (1)	Mean species abundance (MSA)	N/A, see a White Paper on this topic.

2.List all project tasks and timelines

Planning mistakes can magnify and propagate through later deployment phases, resulting in delays, cost overruns, wasted time, and ultimately a compromised system. Much of the trouble can be eliminated by viewing system planning as a data flow model, with an orderly sequence of tasks that progressively transform and refine information from initial concept to final design.

The system planning sequence is the logical flow of thought, activity, and data that transform the initial project idea into a detailed installation plan. In Pacific Internet Solutions the system planning is sequenced into **five tasks** that take place during the **Prepare** and **Design** phases of the project.

These five systems planning tasks occur within the context of other tasks necessary for the overall conduct of the project such as budget analysis, hiring of service providers, and proposal generation. However, the system planning tasks form their own logical sequence that can be extracted and considered by itself.



The figure illustrates these five tasks that comprise system planning, both as they occur in the context of the Prepare and Design phases and pulled out as a separate list of five items.

Hierarchy of information

At each point in the planning process, the information becomes less abstract and more detailed. This hierarchy begins with the determination of three fundamental IT parameters that will directly affect the design of the physical infrastructure system.

- **Criticality:** Business importance, in terms of tolerance for downtime
- **Capacity:** The IT power requirement (expected maximum after ramp-up)
- **Growth plan:** A description of the ramp-up to the maximum power requirement, incorporating uncertainty

Task 1: Determine IT parameters

This task starts with the general idea of a business need that requires a change to the organization´s IT capability. From here, it makes a rough cut at determining three things that begin to quantify the plan for an improved (or new) IT capability. These three things are **criticality, capacity**, and **growth plan**. All are characteristics of the IT function of the data center, not of the physical infrastructure that will support it, which is the ultimate outcome of this planning sequence. In the task that follows this one, these IT parameters will be used to begin developing the physical infrastructure requirements for the data center.

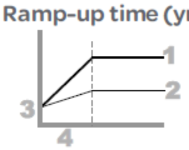
IT parameter	Expressed as . . .	Description
Criticality	1, 2, 3, or 4 (4 is the highest)	The goal for the availability and reliability of the data center, consistent with the business mission For a summary of criticality levels, see APC White Paper 122, *Guidelines for Specification of Data Center Criticality / Tier Levels*
Capacity	kW	Maximum IT power load during data center lifetime This number will be the "maximum final load" parameter in the IT load profile
Growth plan	1. Maximum final load (kW) 2. Minimum final load (kW) 3. Initial load (kW) 4. Ramp-up time (yrs)  IT load profile	The expected IT load over the data center lifetime, expressed as the four-parameter IT load profile For more about this growth model, see APC White Paper 143, *Data Center Projects: Growth Model*

Table: IT parameters

Task 2: Develop system concept

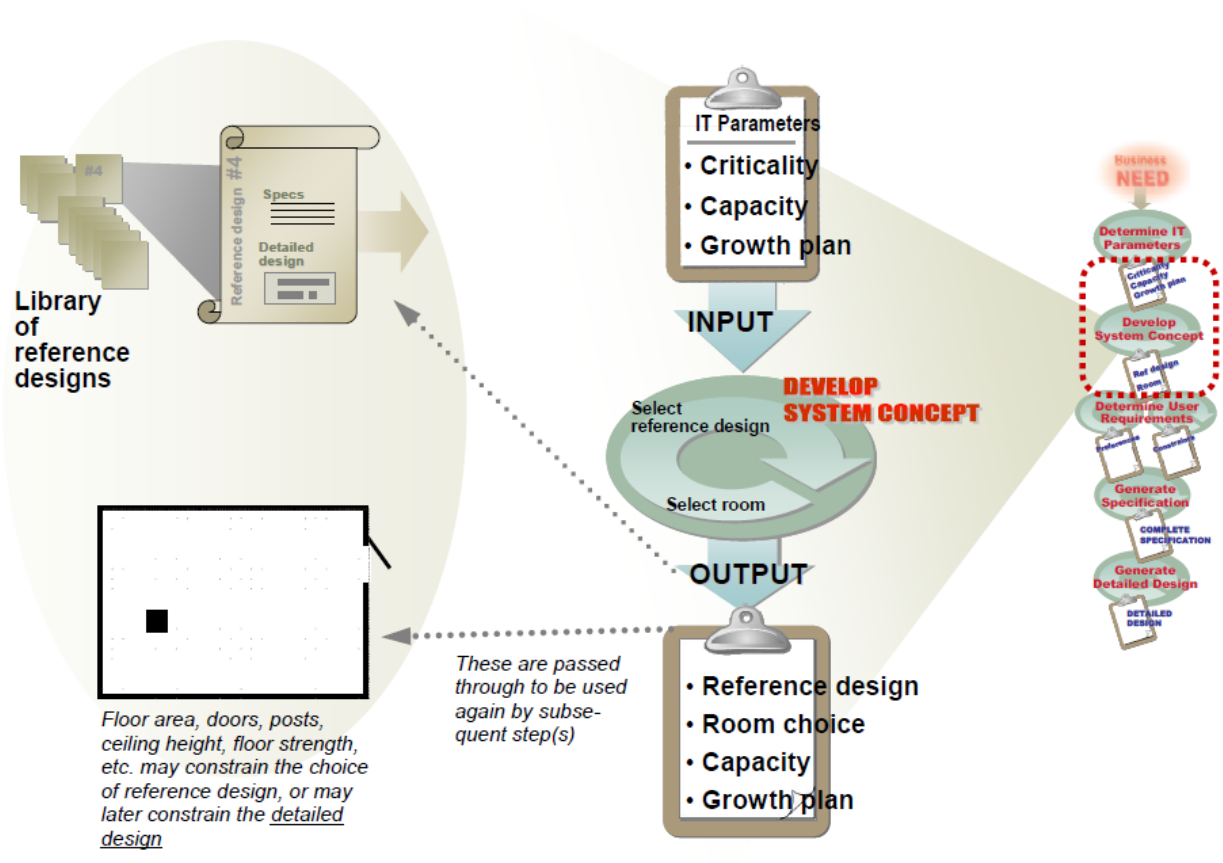
This task takes the foundational IT parameters from the previous task – Criticality, capacity and growth plan – and uses them to formulate a general concept of the physical infrastructure system. The cornerstone of this task is the selection of a reference design, which embodies the desired **criticality** and **capacity**, and has a scalability that will support de **growth plan**.

What is a reference design?: A reference design is an actual system design that is a prototype or "shorthand" representation of a collection of key attributes of a hypothetical user design. A reference design embodies a specific combination of attributes including criticality features, power density, scalability features, and instrumentation level. Reference designs have a practical range of power capacity for which they are suited.

Choosing the physical room: Selection of the physical room where the system will be installed allows for consideration of room characteristics that might constrain the choice of reference design. Examples of possible constraints are room size, location of doors, location of support columns, floor strength, and ceiling height.

Choosing a reference design: The reference design is chosen to support the criticality, power capacity, and growth plan that have been determined in task#1 of the planning sequence. A reference design will have characteristics that make it more or less adaptable in each of these areas

Using reference designs to develop the system concept: In a library of reference designs, there may be more than one design that is compatible with de IT parameters and other requirements specified by the user. The user may want to compare these reference designs to each other or to other alternatives, such as reference designs from other vendors or even to outsourced custom- engineered designs



This figure illustrates the task detail for Develop System Concept

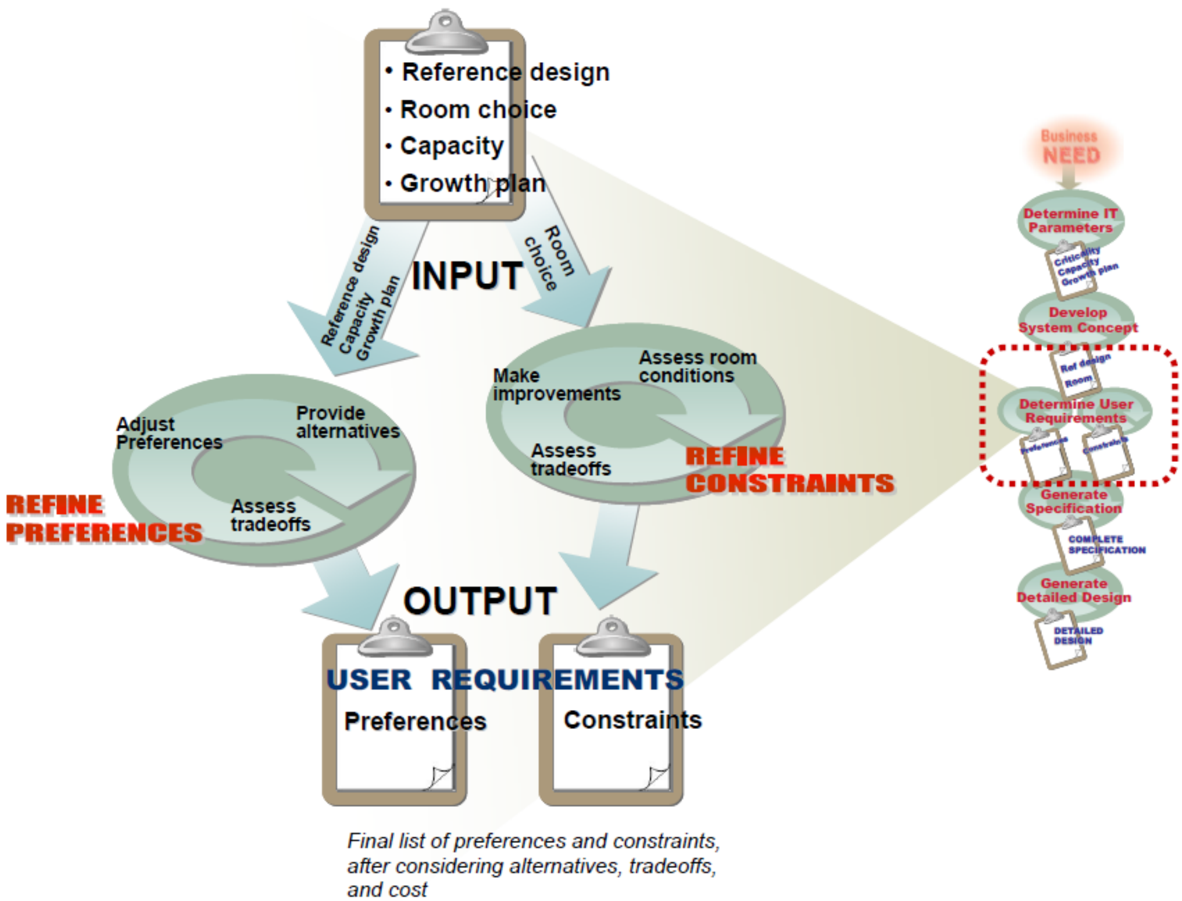
Task 3: Determine user requirements

User requirements include any information about the project that is specific to this user´s project. This task collects and evaluates user requirements to determine whether they are valid, or should be adjusted in some way to reduce cost or avoid problems. User requirements for the project can be such things as key features and options, room constraints, existing IT constraints, and logistical constraints. This task has two halves, dividing user requirements into two general categories.

. *Preferences:* Things that the user would like, but are subject to change or adjustment after consideration (or reconsideration) of cost and consequences. Preferences are things you want, but can change your mind about if you get new information.

. *Constraints:* Things that either cannot be changed, or can only be changed at great expense or with unacceptable consequences. Constraints are pre-existing conditions that are difficult or impossible to change.

Once the preference and constraints are established, a specification for the system can be created (next task), because the preference and constraints become the **user specification** portion of the complete system specification. For more about preference and constraints, see the next task (**Generate Specification**), where they are described in more detail under their new name, **User Specifications.**



The Figure illustrates the task detail for **Determine User Requirements**

Task 4: Generate Specification

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To translate the user requirements (from the previous task) into a detailed design (in the task following this one), this planning sequence uses the intermediate step of creating a system **specification.**

The system specification serves as a set of rules to be followed when creating the detailed system design. The specification consists of the following elements:

. *Standard specification* that do not vary from project to project. These standard specifications comprise the major portion of the specification. Examples of standard specifications are regulatory compliance, compatibility of subsystems, workmanship, safety, and best practices.

. *User specifications* that define the user-specific details of this project. These are the **user requirements** (preferences and constraints) from the previous task, which come from the accumulated work of the planning sequence up to this point.

User-specific elements of the specification: The user-specific portion of the system specification includes information that describes, in detail, everything that is particular to this user´s project. This includes information about all elements of the physical infrastructure system itself, as well as information about other structures and systems that affect the design of the physical infrastructure. The following is a sampling of the user-specific information included: Physical characteristics of the room - electrical service entrance – Row-based peak and average power – UPS runtime required – Power distribution characteristics – Phase-in plan – Type o heat rejection – Type of fire suppression – Type of physical security – Existence of building and/or network management system.

Process specification: A project consists of both the system that is created and the process that does the work to plan and build it. The subject of this paper is the planning of the system, but there is also parallel effort to configure the steps, work assignments, and managements roles of the process. The specification for the total project therefore includes a specification of the process, including both standardized and user-specific elements of the process.

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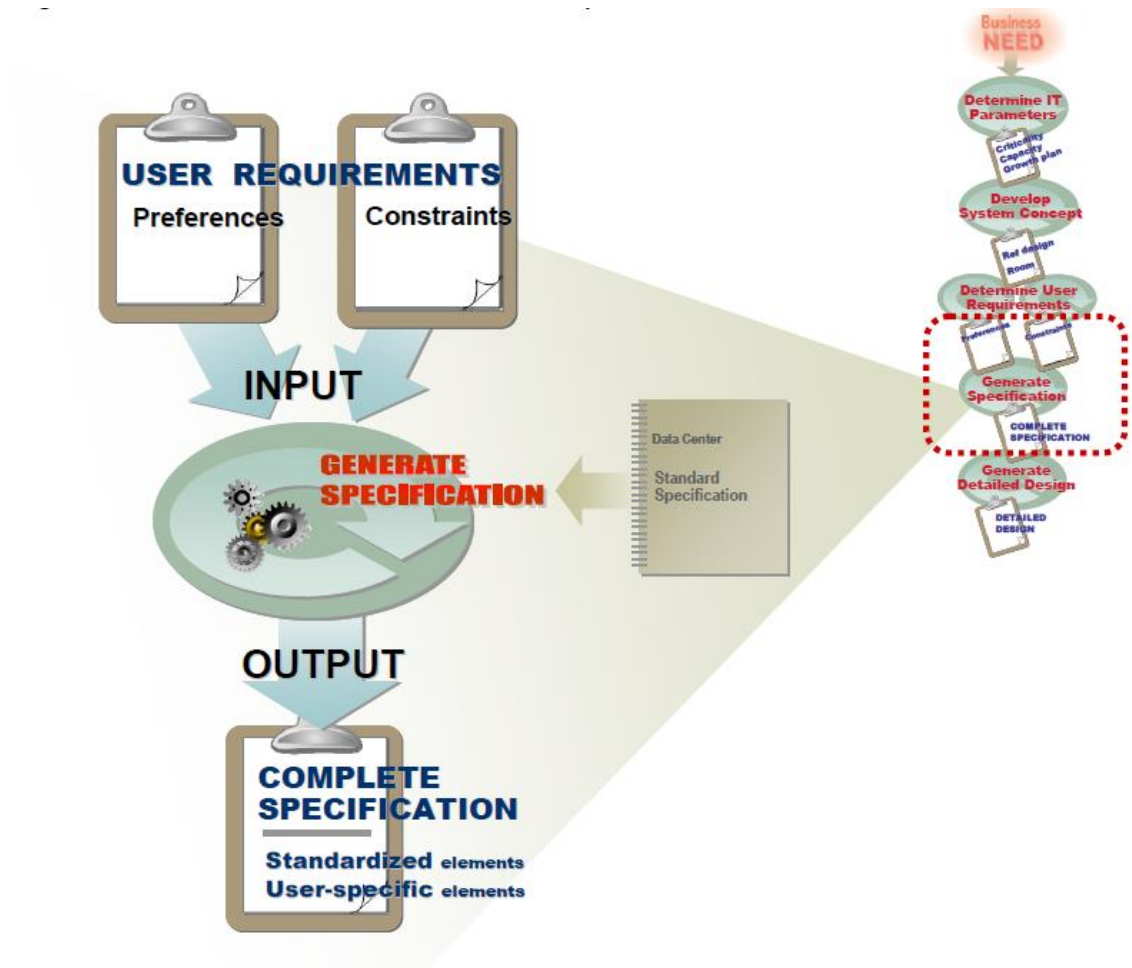


The figure illustrates the task detail for **Generate Specification**

Task 5: Generate detailed design

The last task in the planning sequence is the creation of a detailed design for the installed system, including

. Detailed components list

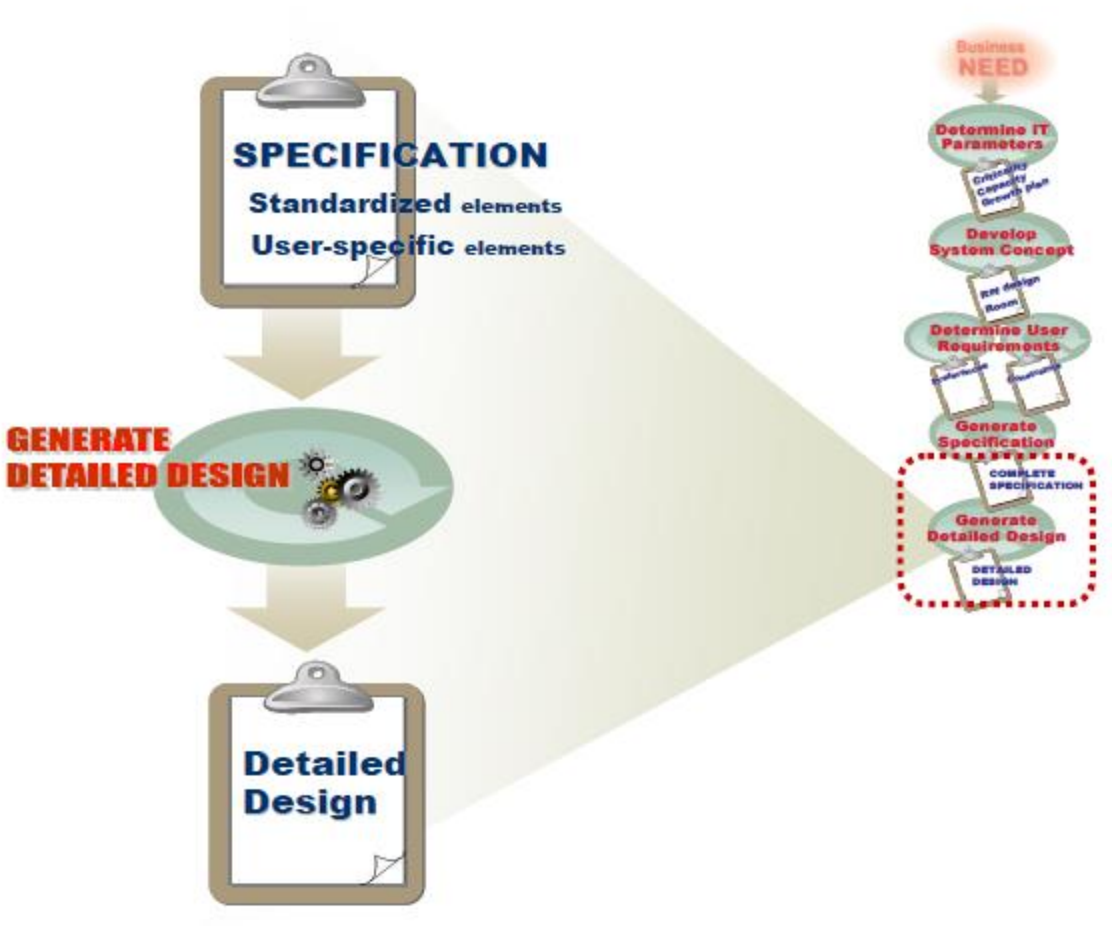
. Exact floor plan of racks, including power and cooling equipment

. Detailed installation instructions

. Detailed project schedule

. Actual “as built” characteristics of the design, including efficiency, density, and expandability

The intent is that the detailed design will meet the complete specification created in the previous task. The complete specification includes specifications for the user-specific details of this system, plus an extensive body of performance-based specifications that apply to any system. To the extent that it meets all those “rules”, the detailed design will represent the system described by the specification.



The figure illustrates the task detail for **Generate Detailed Design**

Summary of data and document relationships: During the course of the planning sequence, a variety of documents and data sets interact and evolve.

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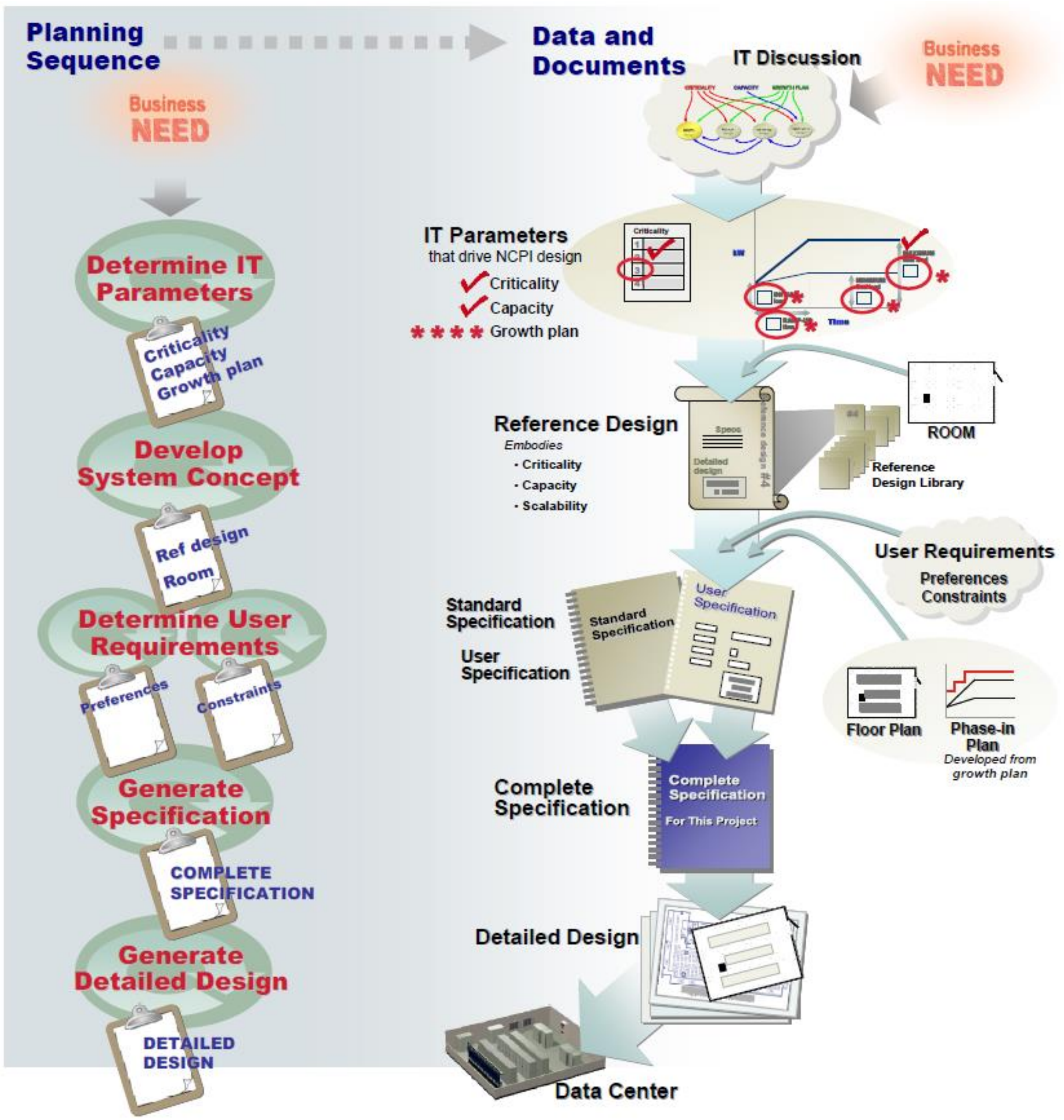
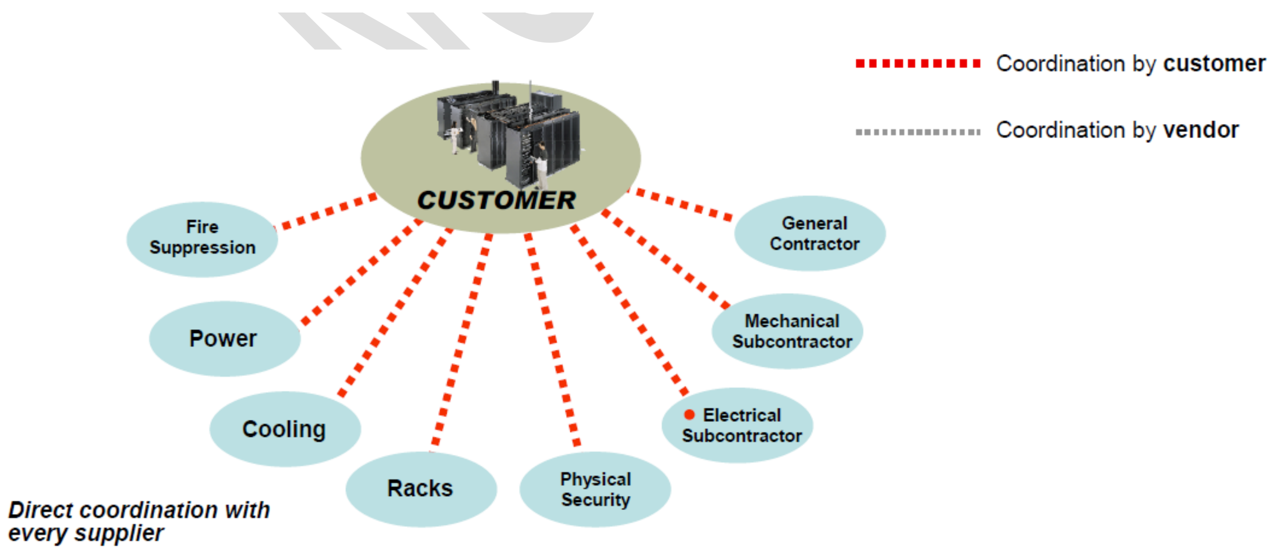


The figure maps the interactions and dependences among these various items of information.

3.Include resource requirements

People components: Most data center projects will have more than one supplier of hardware or services contributing to the work of the project. The costumer may engage separate equipment vendors or, service providers for power, cooling racks, security, fire suppression, electrical work, mechanical work, and perhaps a general contractor if building construction is required. Each supplier of hardware or services will have potential interaction or dependencies with the other suppliers to the project. For example, fire suppression installation depends upon piping and wiring that must be installed first, both of which may be handled by a different supplier.

While each of these suppliers will have its own "project manager" to conduct the work it contributes to the project, there is an additional project role that spans all suppliers: **coordination.** Coordination provides an interface among suppliers with whom there are equipment or time dependencies. It is a role that can be difficult to assign when there are many suppliers to a project.



Bundling project elements under one vendor

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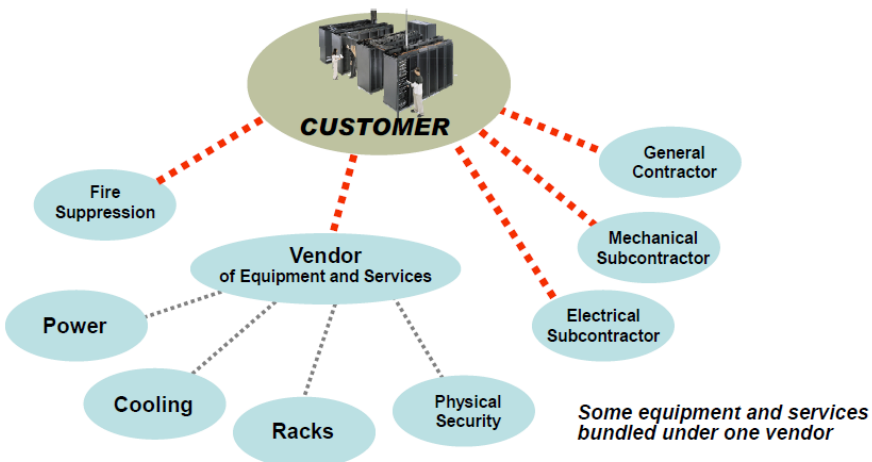

Some equipment and services bundled under one vendor

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Physical components:

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Device	Internal elements requiring PM	Overall maintenance level required
Transformer	Tightness, torque of connections	low
PDU	Tightness, torque of connections	low
Data center air and water distribution systems	Piping internal densities, valves, seats and seals	low
In-Row CRAC	Filter, coil, firmware, piping connections, fan motors	medium
New Generation UPS	Fans, capacitors, batteries	medium
Raised floor	Physical tiles, tile position, removal of zinc whiskers	high
Traditional UPS	Fans, capacitors, electronic boards, batteries	high
Traditional CRAC	Belts, air filters, piping connections, compressor, fan motors, pumps, coils	high
Humidifier	Drain, filter, plugs, water processor	high
Transfer switch	Switch components, firmware, torque	high
External Batteries (wet cell and VRLA)	Torque, connections, electrolyte / acid levels, temperature levels	high
Fire Alarm System	Valves, flow switches	high
Chillers	Oil pressure levels, gas levels, temperature settings	high
Generator	Fuel filter, oil filter, hoses, belts, coolant, crankcase breather element, fan hub, water pump, connections torque, alternator bearings, main breaker	high

The table presents a sample list of physical infrastructure devices that require PM. These systems interact with each other and need to be maintained as a whole system.

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4.Include a training plan detailing requirements - e.g. working with heritage sites or asbestos hazards

The purpose of this Plan is to establish and maintain an effective health and safety management system. PIS s committed to implementing a structured approach to workplace health and safety in order to achieve a consistently high standard of safety performance. This Plan will assist PIS in meeting its obligations in accordance with work health and safety legislation. This Plan applies to all officers and workers and to other persons at risk from work carried out at PIS workplaces. Failure to comply with the requirements of this Plan may lead to disciplinary action.

Responsibilities

As the duty holder, PIS being the PCBU (Person Conducting a Business or Undertaking), must:

_Ensure the health and safety of its workers and others in our workplace.
_Ensure the health and safety of other persons is not put at risk from work carried out as part of its operations.
_Provide and maintain a work environment that is without risks to health and safety.
_Provide and maintain safe plant and structures.
_Provide and maintain safe systems of work.
_Ensure the safe use, handling and storage of plant, structures and substances.
_Provide adequate facilities for the welfare of workers.
_Provide information, training, instruction and supervision.
_Monitor the health of workers and the conditions of our workplaces.

Specific duties as a PCBU also include:

_Record and notify Comcare of any notifiable incidents arising out of the conduct of the business or undertaking.
_Ensure authorizations are in place for any high-risk work or plant.
_Consult so far as reasonably practicable with other PCBUs or persons who have a duty in regard to a work health and safety matter.
_Consult so far as reasonably practicable with workers, their representatives and Health and Safety Representatives on work health and safety matters.

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Training

The Station Manager will conduct a training needs analysis and arrange for appropriate WHS training to be undertaken by workers as required.

Where required, PIS workers are to demonstrate their competencies to perform required tasks safely.

In tasks with a high potential for injury, a separate documented assessment of a person's competency may be undertaken.

As a guide, competency assessments should be signed and dated by the assessor/assessee and contain the following elements:

_Task or equipment description
_Information on licenses held (or other relevant qualifications)
_A checklist containing the essential competencies that were demonstrated
_Comments or confirmation that the competency was met.

WHS Risk Assessment

The purpose of any WHS risk assessment is to ensure that, for any identified hazards, appropriate control measures are implemented in order to protect workers, contractors and visitors from risks to their health, safety and welfare.

Control measures for WHS hazards should be implemented as required using the following hierarchy of control, in order of preference these measures relate to:

_Elimination (removal of the hazard).
_Substitution (substitute the hazard for something which is less hazardous, for example replace a hazardous chemical with one within is not hazardous).
_Isolation (isolate the hazard from people for example place a noisy piece of equipment in another location).
_Engineering (For example guarding on machinery).
_Administrative (for example provision of training, policies and procedures, signage).
_Personal protective equipment (For example use of hearing, eye protection, high visibility vests).

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Whs Issue Resolution

Wherever possible, any WHS concerns will be resolved through consultation between workers, their representatives and/or their manager. If the concern cannot be resolved, then it can be referred to the Station Manager for resolution. Ultimately any issue remaining unresolved may be referred to the Board. Where the issue remains unresolved the default procedure for issue resolution set out in the WHS Regulations must be followed.

If reasonable efforts have been made to resolve an issue and it remains unresolved, any party to the issue can ask Comcare to appoint an inspector to assist in resolving the matter.

Authoritative Sources

_Work Health and Safety Act 2011.
_Work Health and Safety Regulation 2011.
_Approved Work Health and Safety Codes of Practice.

Additional information on these sources may be found at www.comcare.gov.au.

Emergency Procedures

An emergency evacuation plan has been developed and this plan, together with a list of emergency contacts, is displayed in the following locations: Office/reception, common areas, workshops, sheds, male toilets, female toilets.

All fire emergency equipment, such as horns, sirens and fire extinguishers, will be tested by an approved provider every 12 months.

Hazard/Injury/Incident Reporting

How to Report a Hazard or Injury or Incident:

All managers and workers including contractors are required to complete an incident form if a hazard/injury/incident occurs, and:

_Advise the Station Manager of the incident or injury or hazard.

_For recording purposes complete a Hazard/Injury/Incident Report Form.
_Complete the relevant sections of the form giving details of the incident. The form should be completed even when an injury has not occurred, that is, in the event of a near miss.
_All hard copy forms should be signed by the relevant parties.
_The Station Manager or their delegate must record all injuries on the injury register.
_Internal reporting of any hazard/injury/incident should occur is separate from reporting of notifiable incidents to Comcare.

Reporting of Notifiable Incidents

Any serious incidents must be notified immediately to the Station Manager. After becoming aware that any such incident has occurred, it is the Station Manager's responsibility to report 'notifiable incidents' to Comcare by the fastest possible means, either:

_By phone—ring Comcare 1300 366 979
_By fax or other electronic means—fax Comcare on 1300 305 916; email notify@comcare.gov.au.
_ NOTE: Comcare requires that immediate notification is followed within 48 hours in writing by completing a Notifiable Incident

Report Form and forwarding it to Comcare, GPO Box 9905, Canberra, ACT, 2601s

Whs Training and Induction

PIS is committed to providing appropriate training to ensure workers have the skills and knowledge necessary to fulfil their WHS obligations. WHS training is a fundamental requirement for PIS to achieve a safe workplace. The WHS training needs for PIS will be determined in consultation with managers and workers, as well as through review of the WHS Risk Register, however it can be generally categorized into three kinds:

Generic WHS Training: skills and knowledge which is commonly required, example, induction training, WHS risk management training, evacuation procedures.

Risk Specific WHS Training: training required for those persons conducting activities with a specific risk to health and safety or a verification activity, example, first aid training, hazardous substances training, manual handling training, confined spaces training, working from heights.

Task Specific WHS Training: skills and licensing which are required depending on the specific hazards and risk, example, any farm equipment operation, high risk work licenses such as for driving forklifts, cranes.

Workplace Hazard Inspections

PIS is required by WHS legislation to be proactive in identifying hazards in the workplace which may affect the health and safety of its workers and eliminating or minimising the risks arising from those hazards.

In order to ensure a safe and healthy workplace, the Station Manager and/or nominated manager/s accompanied by Health and Safety Representatives (HSRs) should undertake WHS hazard inspections of the workplace regularly and at any other times as required. The hazard inspection should be undertaken by following the principles of WHS risk management.

If any hazards are identified through the hazard inspection process, controls must be implemented to ensure that the risk to health and safety is eliminated or minimized.

In addition to these regular inspections, all managers should also conduct weekly hazard inspections of their work sites in conjunction with HSRs. Any hazards noted during these inspections should immediately be reported to the Station Manager and appropriate remedial action taken.

All hazard inspection documentation should be filed by the Station Manager.

Purchasing

Prior to purchasing any goods or services for the workplace, they should be assessed to determine if there are any associated health and safety hazards. This includes the purchase of equipment such as machinery, tools, furniture, chemicals, as well as contracted services such as maintenance.

Asbestos

It is highly likely that the premises to be occupied by PIS were built before 31 December 2003 and therefore, there is a requirement for PIS to comply with these measures outlined including an asbestos management plan and asbestos register. Do not repair or conduct work on any building without first checking the asbestos register.

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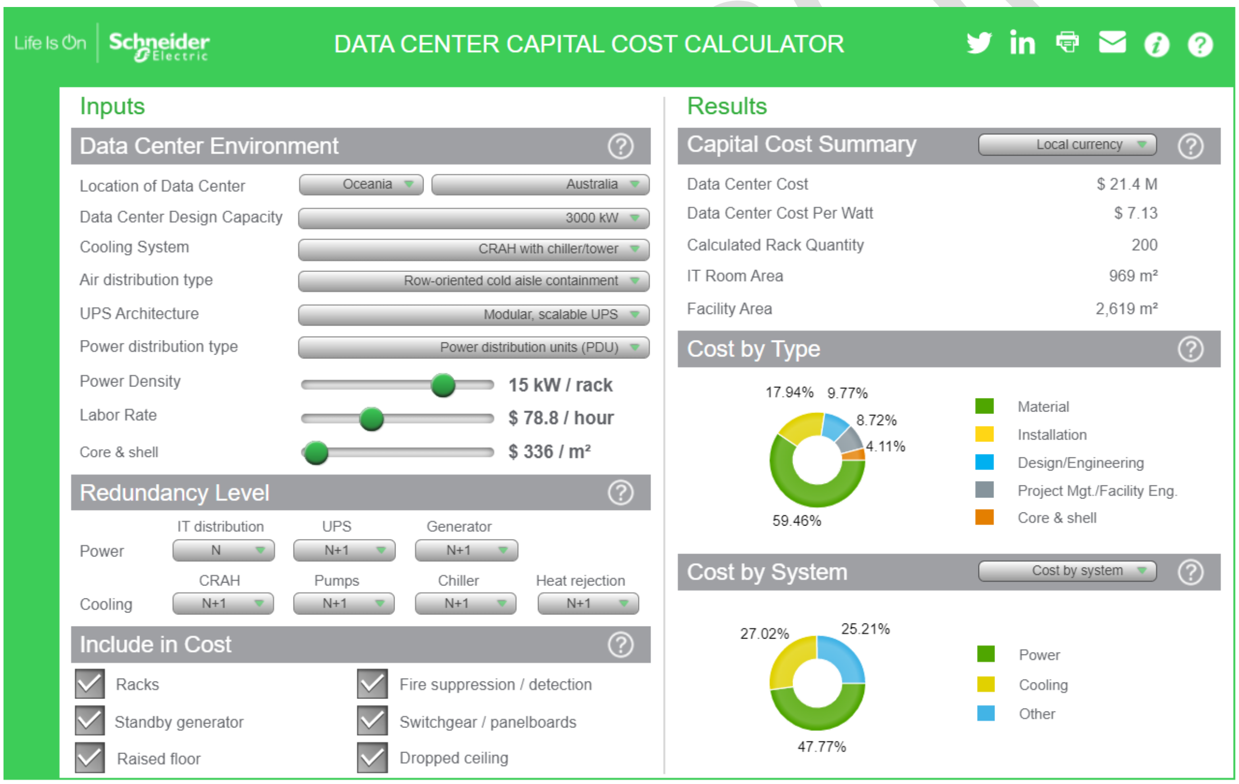
5.Include a budget



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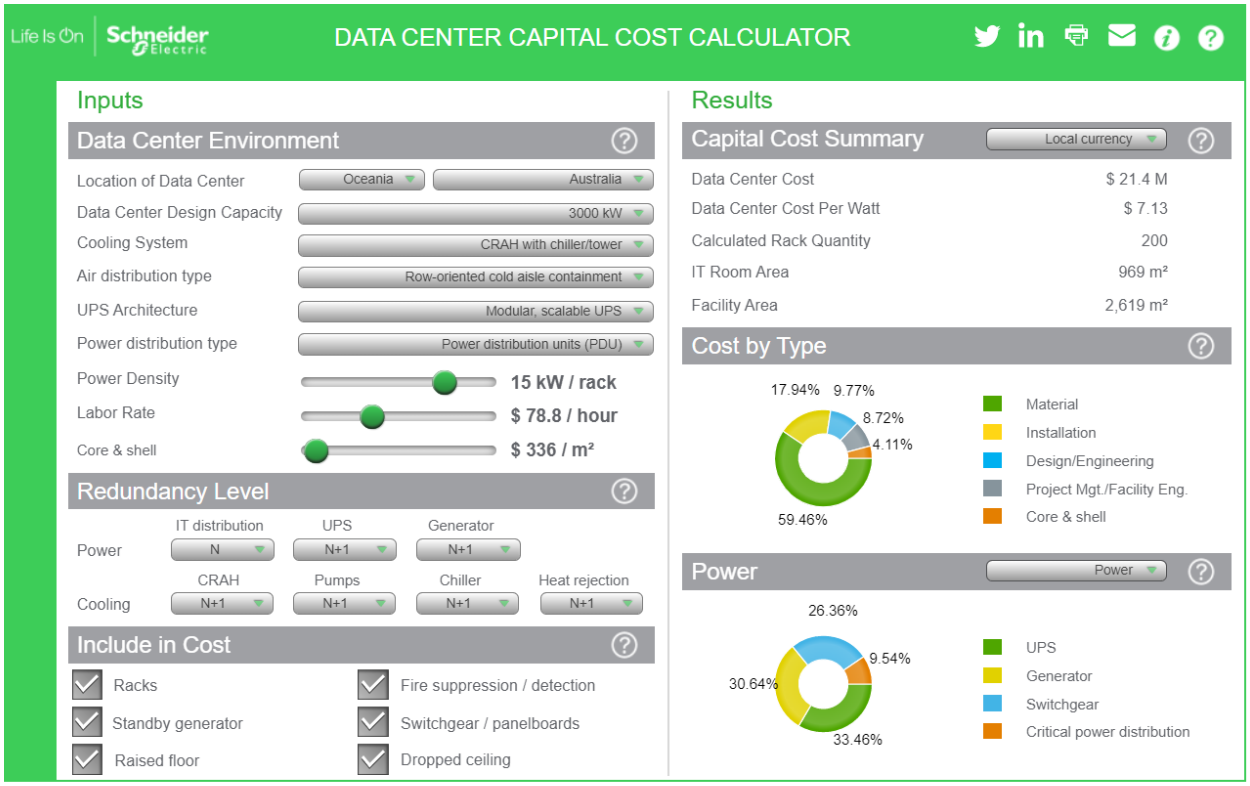

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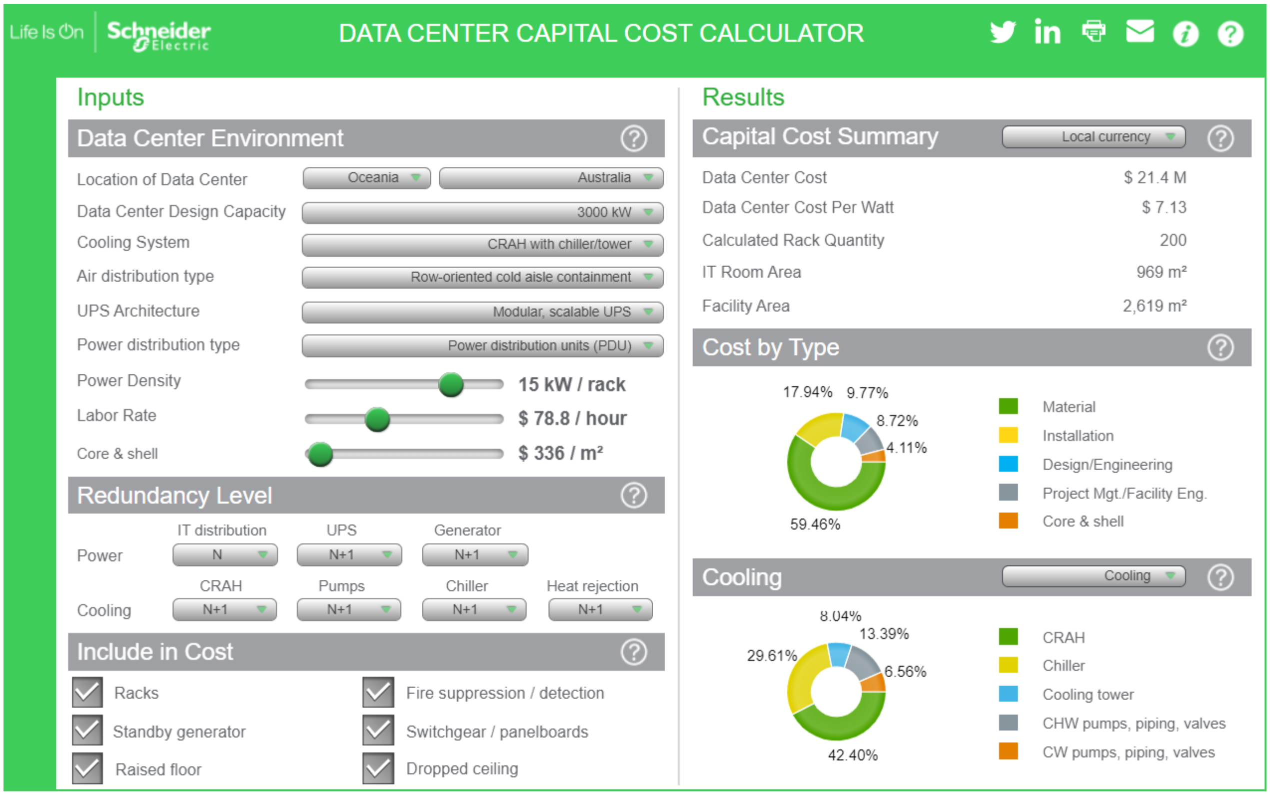

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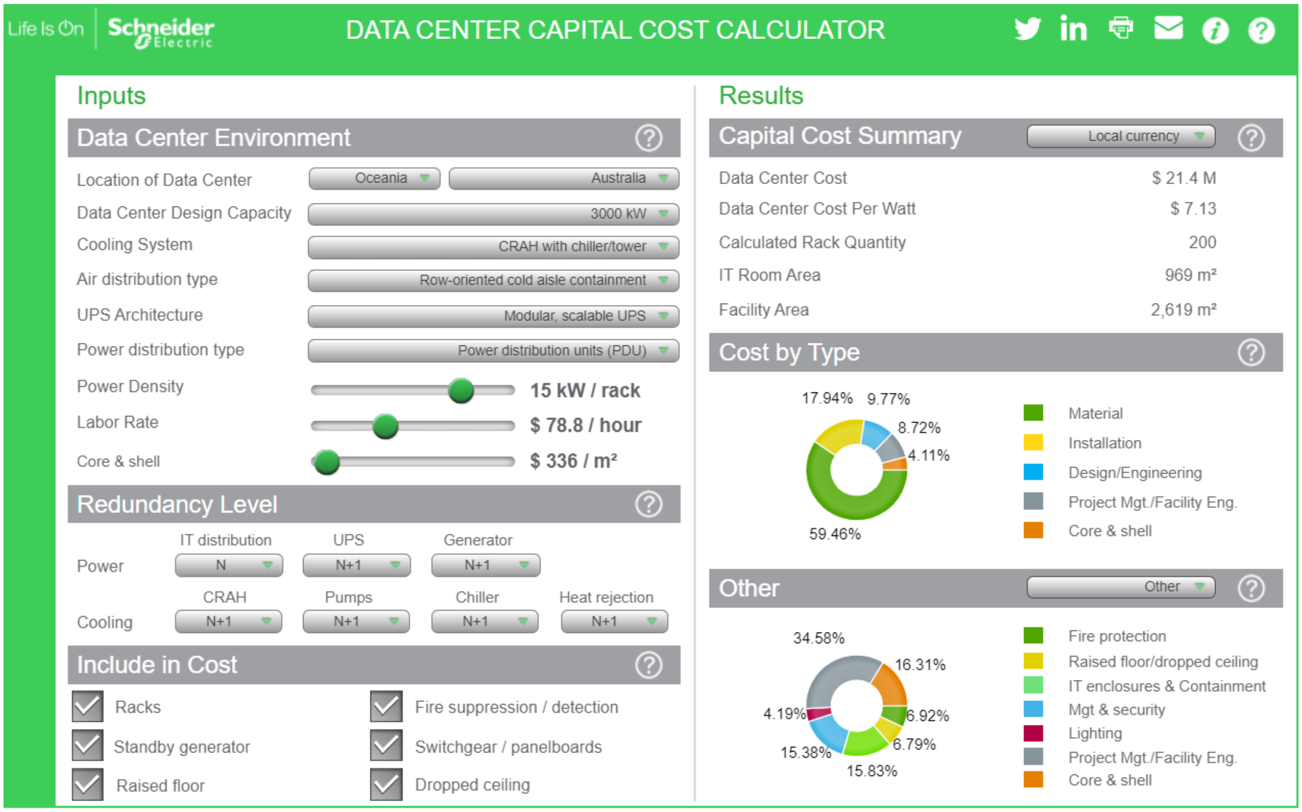

6.Include a commissioning audit document

Failure to properly commission a data center leaves the door wide open for expensive and disruptive downtime that could have been avoided. Integrated commissioning of all physical infrastructure investment. The commissioning process flow is described and critical success factors are discussed. The commissioning process inputs and outputs are also placed in context with other key data center project process phases and steps.

When building a new data center, the owner of the data center has no guarantee that te various physical infrastructure subsystems – power, cooling, fire suppression, security, and management – will work together. Commissioning is the process that reviews and tests the data center´s physical infrastructure design as a holistic system in order to assure the highest level of reliability.

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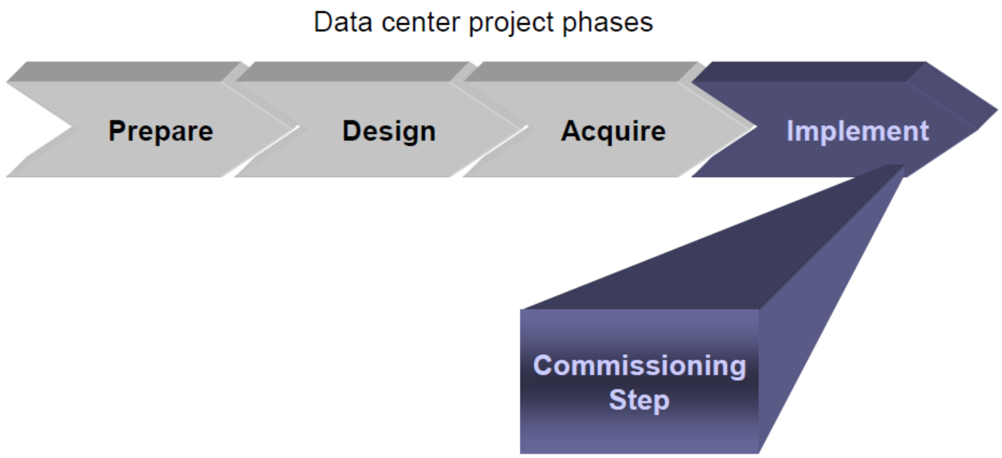

Figure shows Data center design/build project process

The knowledge gained from the commissioning exercise should be documented. The following three documents need to be produced if the commissioning process is to yield some tangible benefits:

_ “As built” script report
_ Component error log report
_ Trending report

The “as built” script report highlight the specific system components tested, describes what kinds of tests were performed, and provides a line-by-line account of how each component either passed or failed the test.

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1. Data center description
- A. size in sq ft / sq meters
- B. key physical infrastructure components
- C. component redundancy levels
- D. overall data center criticality level

2. Data center design criteria
- A. Physical floor plan demonstrating physical infrastructure equipment locations (includes racks)
- B. Floor plan denoting power distribution
- C. Floor plan denoting coolant, chiller and fire suppression piping
- D. Floor plan with existing air flow patterns

3. Component verification
- A. model specified (manufacturer, model name, model number, asset ID number)
- B. model delivered (manufacturer, model name, model number, asset ID number)
- C. model installed (manufacturer, model name, model number, asset ID number)
- D. model capacity (kW, volts, amps)
- E. general equipment condition

4. Performance data
- A. test procedures
- B. expected response
- C. actual response
- D. designation as pass or fail

"As built" report

The component error log, also known as Failure Mode Effects Analysis (FMEA) focuses on the specific system components that failed the tests and documents how the failed test impacted other components either upstream to or downstream of the component in question.

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Test area / procedure no. / and sequence ID	Failure / reason for failure	Impacted system	Corrective action
Test area: power Procedure: 21 Sequence: 12	**Failure:** UPS failed to support load after switching from by-pass mode to full function. **Reason:** Battery leads at the head of battery string were disconnected	Generator, Load Banks and battery banks	Have chief electrician verify that all battery leads are properly connected and rerun test.
Test area: cooling Procedure: 38 Sequence: 3	**Failure:** Chilled water failed to circulate to CRACS **Reason:** Pump located between condenser and CRAC failed to start	Chiller, CRAC, Condenser	Have facilities engineer replace pump with spare unit until new unit can be installed.
Test area: fire system Procedure: 42389 Sequence: 8	**Failure**: Smoke detector A6 failed to raise alarm when tested **Reason**: Faulty sensor near intake	Air distribution system, Sensor aggregation point, Smoke detection unit.	Contact vendor to replace smoke detection unit

Example the component error log report

Once actual commissioning is completed, a trending report is issued. This report includes a management summary of identifiable system performance trends. The summary also contains a high-level system description, highlights issues that were encountered and resolved, and identifies issues that remain open for future action.

Executive summary

1. Data center overview
2. Summary of pre-commissioning data (i.e. component start up data)
3. Summary of commissioning scope

Commissioning methodology overview

1. Procedures tested
2. Sequence of testing

Data center commissioning system performance trends

1. Includes data center physical infrastructure power input and heat output
2. Projected energy consumption report with both energy-use index (EUI) and energy-cost index (ECI). The EUI is kW per air conditioned sq foot of the data center. The ECI is dollars per conditioned square foot per year.
3. Analysis of error logs, with emphasis on root causes.

Conclusion

1. Possible impacts of future expansion

Commissioning trending report

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Commissioning process

Key commissioning processes include the following:

1. Planning
2. Investment
3. Selection of a commissioning agent
4. Scripting
5. Setting up of a command center
6. Testing
7. Documenting

Planning: The commissioning process begins months ahead of the actual delivery of the physical infrastructure equipment. Regular commissioning meetings should be held several weeks ahead of the actual commissioning date. Vendors of the various component subsystems should provide start-up documentation as part of the planning process. At these planning meetings, primary and secondary stakeholders are kept informed of how the commissioning schedule will be organized. Plans can be formulated at these meetings to set up event sequencing and to coordinate schedules. The responsibilities of the team members who are engaged in the process should be clearly defined in the planning stages.

Investment: Determining how much commissioning should be performed depends on the business expectation of cost and need. The more thorough the past commissioning process, the faster and less costly future commissioning projects will be. Commissioning comes back to playing the role of an insurance policy for data center reliability.

Selection of a commissioning agent: When engaging a commissioning agent in medium to large organizations, a recommended best practice is to assure that the commissioning agent is independent. This practice is driven by an organization's desire to enhance its corporate image by leveraging independent validations.
Finance departments embrace a similar approach regarding the independence of outside auditors. Most companies subscribe to generally accepted accounting principles (GAAP).

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GAAP requires the engagement of an independent audit agency to validate all public financial data. The audit agent is not permitted to maintain any secondary relationships that could compromise the independent review. Most companies' internal audit requirements mandate that the commissioning agent conform to the same rigid practices that are imposed on the finance department.
Once the contractor team has been selected by the owner, the commissioning agent should get involved early in the project process. Early engagement provides the cleanest, least filtered information and enhances the ability of the team to identify potential single points of failure (SPOF). Involving a commissioning agent early on also reduces the possibility of having the commissioning process fall victim to budget cuts, should the project experience cost overruns.

Scripting: Prior to the integrated testing of equipment, a comprehensive test script must be created. Scripting is important because it provides a time-sequenced and order-based roadmap for testing all key data center elements. The script also captures a record of all the test results. By following the script, the commissioning team can observe and validate how each physical infrastructure component influences the operation of linked components.

The scripting is usually performed by the independent commissioning organization. If a company or owner chooses not to engage an independent commissioning agent, then the design engineer or the construction company can perform the scripting process. The master script is developed over the entire length of the construction process and refined for each physical infrastructure element.

Scripting must first validate that all subsystems are tested using the manufacturer's start-up process. Vendors of the various component subsystems should provide start-up documentation and have it added to the script well in advance of the commissioning dates. Regular scripting meetings should be held prior to the actual commissioning date. When all the independent subsystems have been scripted, they are incorporated into a cohesive system script.

Once the various start-ups are validated and the assorted scripting documents are in order, the integrated testing process can begin.

Setting up of a command center: Depending upon the complexity and size of the integrated commissioning test, a command center may be required. Smaller data centers may simply designate an individual who can act as the command center – a communication "hub" – during the testing process. The purpose of the command center is to coordinate various testing activities, to give next step testing permission, to handle all internal and external communication, and to have all contact and emergency phone numbers available.

It is vitally important that the individuals actually performing the commissioning task not be overburdened with external communication and documentation details; this is the command center's responsibility. The testing group needs to focus on safety and testing.

Testing: Every piece of equipment should be tested by executing a sequenced failure followed by a restart and return-to-stable operation. A sequenced failure implies that a failure in one component (such as a generator) is communicated to a second related component (such as the air conditioning system) so that the second component can act in an appropriate manner to minimize downtime or to be ready for action when power is restored. This testing cycle should be performed on each component and also on the entire integrated system. This will involve a complete power down and an automatic restart.

Power: This aspect of the commissioning process tests the high voltage electrical service entrance. It then progresses forward to the medium voltage main power distribution system, including parallel switchgear, transfer switches, emergency generator, UPS system, the data center monitoring system, and the distribution down to the racks. All lighting and life safety systems including emergency power off systems (EPO) are also tested. Finally, electrical system commissioning should include a short-circuit and breaker coordination study using electrical scripting to verify that all circuit breaker and ground fault trip settings are correct.

Cooling: The cooling components include the cooling towers (including incoming water sources), chillers, piping, pumps, variable speed drives, chemical or other water treatment systems, and filtration systems. It also includes building humidification, ventilation, heating systems, and computer room air conditioners (CRACs).

Fire suppression: This begins with an analysis of the incoming water and post indicator valves (PIVs), works through the alarm systems and automated reporting systems, and ends with the sprinkler and or clean agent (gas) fire suppression systems.

Monitoring and management systems: Commissioning of the building management and energy management monitoring and control systems is incorporated with each primary system test. Each alarm should be verified.

Physical security systems: The central security station site video monitoring, physical security devices such as mantraps and card readers, and central sound system are also tested during commissioning. All wall duct penetrations should be double checked to determine whether security bars have been installed. These security bars can prevent an intruder who has gained access to the roof, for example, from entering the data center by climbing down a large air duct.

Spare parts: If deploying some of the newer, modular / scalable UPSs or similar equipment, spare parts, such as backup power modules, should also be included as part of the commissioning process. For example, the original power module should be included in the first test. Then that module should be pulled out and replaced with the spare module. The test should be run again to verify that both the original and spare modules work correctly. The spare module should then be properly stored in a secure environment until it is ready to be deployed as a replacement part.

Scripting checklist

A second valuable tool utilized in the commissioning process is the scripting outline. In most cases the commissioning agent will use a standard master script outline that is modified based upon the system components in the particular installation. During actual testing, the script should be a hand-held paper or electronic document containing a test procedure articulating the projected outcome of each event. It should also contain check off boxes for each test with space for comments and test results. Each person associated with the test should have an identical copy of the test script. The scripting documentation, if Figure 9 Rack-mounted server simulator has adjustable heat and air flow settings properly designed and assembled, is a powerful tool for the IT staff to utilize in order to proactively prevent future system failures.

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Line number	Check off box	Description	Results	Proceed?	Initials
132	✓	**Basic operational tests – manual transfers**	n/a	Yes	______
133	✓	(carry out the following functional tests)	n/a	Yes	______
134a	✓	ATS racked in "CONNECTED" position	pass	Yes	______
134b	✓	ATS not bypassed	pass	Yes	______
134c	✓	Closed-transition transfer capability disabled	pass	Yes	______
135	✓	**Test steps**	n/a	Yes	______
136a	✓	Verify that above conditions are satisfied	pass	Yes	______
137b	✓	Move ATS to "TEST" position	**fail**	**No**	______
137c	____	Bypass ATS to Normal source			
137d	____	Move ATS to "TEST" position			
137e	____	Move ATS to "DISCONNECTED" position			

Abbreviated example of closed-transition transfer switch test script

7.Include work health and safety requirements

Specific WHS Requirements

Inappropriate Behaviour: Bullying, harassment, discrimination and violence of any form will not be tolerated at PIS. PIS undertakes to investigate all complaints formally made. PIS will take action to resolve the complaint. If the complaint is found to be valid, action may include any combination of the following:

_Asking for an apology.
_Creating an agreement with the offender that will stop the behaviour of concern.
_Conciliation/mediation conducted by an independent/impartial third party to seek a mutually acceptable solution.
_Disciplinary action in the form of verbal, written or final warning or dismissal.
_All violence will be reported to the police.

In determining the action to be taken, the following factors will be considered:

_Severity and frequency of the behaviour.
_Whether there have been previous incidents or prior warnings.

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Dangerous goods and hazardous substances: Hazardous substances are chemicals, organic matter and other substances which pose a health risk when people are exposed to them. These may include glues, paints, solvents, corrosives, adhesives, thinners, cleaning solutions, chemicals, flammable and Dangerous Goods. Dangerous goods are hazardous substances that are also explosive or flammable in nature with storage required that is fit for purpose.

All chemicals will be included in the hazardous substances register and have their current Safety Data Sheet (SDS) present for each chemical on the register. All workers shall have access to information about the chemicals in the event of a spillage or exposure, even where PIS workers would not normally use the chemicals directly. Quantities of hazardous substances stored for use shall be kept to a minimum.

A hazardous substances register will be developed to record any substances purchased or used by the PIS. This will be reviewed on a regular basis.

Electrical Safety: Failure to maintain electrical equipment in a safe condition, or to use equipment in accordance with manufacturer's instructions may result in injury or death to workers or other parties.

All electrical equipment must be protected from damage, used safely and checked regularly. In addition, there are other requirements that must also be implemented for "specified electrical equipment". These requirements include combinations of testing and recording and connection to safety switches.

Regular inspection and testing of in-service electrical equipment by a competent person is a way to ensure this safety duty is met. The WHS legislation requires that electrical equipment is inspected and tested in accordance with Australian Standard 3760: 2010

In-service safety inspection and testing of electrical equipment. Only authorized electrical personnel are to perform installation, inspection, testing and labelling activities.

Confined Spaces: All confined spaces are placarded with access strictly controlled. Entry requires the issue of a confined spaces permit on each occasion. No employee or contractor will be issued a permit to work in any confined space on the property unless they are trained and supervised. When working in a confined space a trained bystander must be present at all times. A register of identified confined spaces and entry permits is maintained at the office.

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Falls from Height: There is a risk of serious injury from falling when working above ground height. No worker will work at height without ensuring that ladders, steps and handrails are secure or fall prevention/arrest harnesses are in place. These structures include, but are not limited to:

_Overhead fuel, water tanks and windmills.
_Buildings and roofs.
_High machinery; cherry pickers, trucks and trailers.

PIS will ensure that:

_Workers working at height are made aware of the hazards and risk management procedures.
_Fall arrest or fall prevention harnesses are provided and used.
_Workers are instructed in the correct use of fall prevention or fall arrest harnesses.

Contractors will ensure that they:

_Observe and apply risk management procedures when working at heights.
_Use the required personal protective equipment (PPE) where indicated.
Plant and equipment: The definition of plant encompasses hand tools either powered or non-powered (electric drills, hammers) and extends to farm machinery, office furniture and any other equipment used for work purposes.

Risk Management: A risk management process is a systematic method for making plant as safe as possible and can also be incorporated into other workplace risk management systems. This risk management approach should be undertaken before purchasing of, or alterations to plant, changing the way it is used, relocating it, or if additional health and safety information becomes available.

Maintenance and repair: Plant must be maintained and cleaned following the procedures recommended by the designer or manufacturer or by a competent person. Only a competent person may inspect and repair damaged plant.

Unsafe and/or malfunctioning plant and equipment can be identified by any manager, worker or contractor by a number of methods such as:

_Equipment inspections.
_Verbal reporting of equipment malfunction to the appropriate manager.
_Hazard and incident reporting.

Once identified, the unsafe or malfunctioning plant/equipment should be reported to the appropriate manager in order for repair to be organized. Plant/equipment which has been identified as unsafe should be disconnected from the power supply and clearly labelled as unsafe and not be used. If possible, the plant/equipment should be moved to a location where it is not accessible.

Personal Protective Equipment: Personal Protective Equipment (PPE) may be required to protect managers and workers during general, specific and hazardous tasks. PPE is the least effective way to control risk and is always the last resort to protect workers. The types of PPE used at PIS might include:

_Respirators and masks
_Foot protection (safety shoes and boots)
_Body protection (high visibility clothing, long sleeves, wide brimmed hats, gloves)
_Helmets
_Any substance used to protect health, for example, sunscreen.
If required, workers are obliged to use PPE when required and when reasonably practicable. Other requirements include:

_Workers should be fully trained in the safe use, storage and maintenance of PPE
_PPE must be checked before use for the correct type, fit and undamaged
_Do not reuse disposable, contaminated or damaged PPE
_Store PPE correctly.

Slips, Trips and Falls: Slips, trips and falls are one of the major types of accidents in workplaces and may be due to poor housekeeping practices such as water or oil spilt. Material placed untidily or using walkways for storage can also be a cause of these types of incidents. When assessing the potential for slips, trips and falls, make sure you look at out of sight areas such as storage rooms, stairways and workshops.

Prevention: Reduce the risk of injury by following these guidelines:

_Avoid walking on slippery floors.
_Keep floors free of water and grease.
_Clean floors regularly.
_Post warning signs around spills or wet floors.
_Install non-slip tiling or other non-slip floor products.
_Use rubber mats in areas where the floors are constantly wet.
_Use non-slip footwear.

_Clean up spills immediately.
_Install adhesive strips and slip resistant paint to improve slip resistance. The best method will depend on the existing floor surface.
_Use floor cleaning products to remove oil and grease.
_Agree on written standards with contract cleaners to ensure that any cleaning agents leave the floor in a non-slip condition.
_Use storage areas for equipment and be alert to the dangers of leaving boxes, rubbish, bags and furniture in walkways, entrances and exits.

Drugs and Alcohol: PIS maintains the right to refuse work to any worker or contractor who, in the opinion of management, is in an unfit state to perform their work in a safe manner.

To assist in these requirements, PIS workers, contractors and visitors shall observe that:

_No alcohol may be consumed or permitted on property at any time unless expressly authorized by management and only when work is completed for the day.
_No illegal drugs shall be consumed or permitted on property at any time or under any circumstance.
_If, in the opinion of management, a worker is unfit to work safely, they will be sent/taken home.
_Workers who are taking prescription medication that may affect their safety at work (that cause drowsiness), are to inform management of the circumstances so that appropriate duties may be assigned.

PIS encourages all employees not to smoke. Please do not smoke in any vehicle, tractor or building.

Vehicles: *Alcohol and Drugs*: PIS managers and workers must not drive a personal or PIS vehicle on work related business in circumstances where that member would breach applicable road transport law by driving under the influence of alcohol or drugs.

Licenses: PIS managers and workers who are required to drive a vehicle on work related business must hold a current valid driver's license of the appropriate class and notify the Station Manager if the license is suspended or revoked. A copy of the current driver's license must be provided to the Station Manager or their delegate to be retained on file.

Mobile Phones: The use of a hand-held mobile telephone while driving is a safety risk and is against the law. PIS managers and workers are not to use a hand-held mobile telephone while driving a motor vehicle or other motorized equipment at a PIS workplace.

Seat Belts: It is a legal and PIS requirement that seat belts are worn at all times in a moving vehicle. The driver is responsible for ensuring that all passengers wear a seat belt when the vehicle is in motion on a public road or at a PIS workplace.

Smoking: Smoking in any PIS vehicle by either drivers or passengers is prohibited.

Working Alone: The risk of injury or harm for people who work alone may be increased because of difficulty contacting emergency services when they are required. Emergency situations may arise because of the sudden onset of a medical condition, accidental work-related injury or disease, attack by an animal, exposure to the elements, or by becoming stranded without food or water.

The consequences of an incident arising when working alone may be very serious so PIS managers and workers shall implement the following for each alone work task:

_A telephone call to home base on arrival and departure at a remote work site
_Development and approval of trip itineraries for extended trips and adherence to the itinerary
_Pre-trip agreement on departure and arrival times and accommodation arrangements
_For travel in remote areas an emergency location beacon should be carried in the vehicle
_Pre-arranged mobile/satellite phone calls at scheduled times
_Appropriate first aid kit
_Sufficient water for emergency purposes.

8.Include a gantt chart

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ID	Task Name	Start	Finish	Duration	Apr 2023																											
					3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Prepare	4/3/2023	4/7/2023	5d																												
2	Assess Needs	4/10/2023	4/14/2023	5d																												
3	Develop Concept	4/17/2023	4/21/2023	5d																												
4	Configure Project management roles and responsabiities	4/24/2023	4/26/2023	3d																												
5	Commit to project	4/27/2023	4/28/2023	2d																												

ID	Task Name	Start	Finish	Duration	May 2023																														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Design	5/1/2023	5/31/2023	23d																															

ID	Task Name	Start	Finish	Duration	Jun 2023																													
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Initialize Project	6/5/2023	6/16/2023	10d																														
2	Establish Requirements	6/19/2023	6/23/2023	5d																														
3	Configure Solution	6/26/2023	6/30/2023	5d																														

ID	Task Name	Start	Finish	Duration	Jul 2023																										
					3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Finalize Proposal	7/3/2023	7/14/2023	10d																											
2	Create Purchase Order	7/17/2023	7/21/2023	5d																											
3	Acquire	7/24/2023	7/28/2023	5d																											

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ID	Task Name	Start	Finish	Duration	Aug 2023																														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Site Coordinator	8/1/2023	8/4/2023	4d																															
2	Shipment	8/7/2023	8/18/2023	10d																															
3	Equipment Delivered	8/21/2023	8/31/2023	9d																															

ID	Task Name	Start	Finish	Duration	Sep 2023																									
					4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Implement	9/4/2023	9/15/2023	10d																										
2	Assembly	9/18/2023	9/22/2023	5d																										
3	Installation by Subcontractors	9/25/2023	9/29/2023	5d																										

ID	Task Name	Start	Finish	Duration	Oct 2023																									
					2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	Start-up	10/2/2023	10/13/2023	10d																										
2	Network Integration	10/16/2023	10/27/2023	10d																										

ID	Task Name	Start	Finish	Duration	Nov 2023																								
					6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Orientation and Training	11/6/2023	11/24/2023	15d																									
2	Project Complete	11/27/2023	11/30/2023	4d																									

2. Produce an annual preventive maintenance plan for the data centre. *References - Schneider Electric - Preventive Maintenance Strategy, Schneider Electric - Reference Design 33*

Preventive Maintenance (PM) is sometimes neglected as an important tool for controlling the Data Center and downtime. The PM es performed specifically to prevent faults from occurring. As data center´s manager we will improve systems through a better understanding of PM best practices. An integrated approach to PM allows the data center owner to hold one partner accountable for scheduling, execution, documentation, risk management, and follow up. This simplifies the process, cuts costs, and enhances overall systems availability levels.

To optimize efficient PM, we support a robust implementation of holistic and integrated PM practices. Since the IT systems and physical infrastructure are close coupled in the data center, all the staff must work together for a better final PM.

We have decided to carry out the PM for all human and other resources in the same week for 5 days.

We will call a qualified PM provider partner who will provide the service for us. with minimal disruption and maximum recovery options. With this we seek to save time and money and improve the overall performance of the data center.

We have also decided to carry out our PM with a PM by manufacturer service since it will guarantee us greater security in terms of physical components of the parts that need to be replaced and it is also worth mentioning the experience of the staff, which is undoubtedly an important factor for maintenance.

The PM provider must provide us with a detailed statement of work that must include the following:

_ Dispatch provisions: Proper protocols should be followed in order to assure easy access to the equipment at the data center site.

_ Parts replacements provisions: This include recommendations regarding which parts need to be “preventatively” replaced or upgrades

_ Documentation: Specify a PM output report that documents the actions taken during the PM visit.

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We have chosen the month of April to carry out our PM Due to external environmental conditions, processes in neighboring facilities and social and economic conditions. Next, we will detail the calendar and the tasks to be carried out for that day.

PM visit Previous Week	**Internal Environment**	**External Environment**		
Check and observation	**Hands-on** . Appearance of circuit boards . Appearance of sub-assemblies . Appearance of cable harnesses . Connectors . Filters . Windings . Batteries . Capacitors . Insulation . Ventilation **Non-invasive** . General appearance . Thermal scanning readouts . Predictive failure reports . Internal temperature reading	. Overall cleanliness . Temperature levels . Acidity levels . Presence of corrosion . Frequency of disruptions . Presence of dripping water . Dust content of area . Hot spots . Ventilation obstruction . Access hindrance . Open windows and doors . Nearby construction . Radio usage . Roof penetrations . Noise quality of equipment . Connections of equipment to earthing cables		
Weekdays	**Device**	**Internal elements requiring PM**	**Overall maintenance level required**	**Maintenance scheduling practices**
Monday	Generator	Fuel filter, oil filter, hoses, belts, coolant, crankcase breather element, fan hub, water pump, connections torque, alternator bearings, main breaker	**HIGH**	**Weekly**

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	Traditional CRAC	Belts, air filters, piping connections, compressor, fan motors, pumps, coils	**HIGH**	**Weekly**
	Traditional UPS	Fans, capacitors, electronic boards, batteries	**HIGH**	**Weekly**
	Humidifier	Drain, filter, plugs, water processor	**HIGH**	**Weekly**
Tuesday	Chillers	Oil pressure levels, gas levels, temperature settings	**HIGH**	**Weekly**
	Transfer switch	Switch components, firmware, torque	**HIGH**	**Weekly**
	Fire alarm System	Valves, flow switches	**HIGH**	**Weekly**
	External Batteries (wet cell and VRLA)	Torque, connections, electrolyte / acid levels, temperature levels	**HIGH**	**Weekly**
Wednesday	Raised floor	Physical tiles, tile position, removal of zinc whiskers	**HIGH**	**Weekly**
	In-row CRAC	Filter, coil, firmware, piping connections, fan motors	**MEDIUM**	**Monthly**
Thursday	New Generations UPS	Fans, capacitors, batteries	**MEDIUM**	**Monthly**
	Data center air and water distribution systems	Piping internal densities, valves seats and seals	**LOW**	**Quarterly**
Friday	PDU	Tightness, torque of connections	**LOW**	**Quarterly**
	Transformer	Tightness, torque of connections	**LOW**	**Quarterly**

Maintenance contracts should include a clause for PM coverage so that the data center owner can rest assured that comprehensive support is available when required. The current PM process must expand to incorporate a “holistic “approach.

3. Make a list of high-risk activities that could be associated with construction and working in a Data Centre. *References* - *https://www.safetysure.com.au/safety-advice/managing-work-health-safety-in-a-data-centre/*

In assessing safety in a data centre there are some key process hazards that must be considered. These include:

_ **Fire suppression systems:** Data centres are hot enviroments and a fire could cause substantial issues for data retrieval. That´s why most data centre operators use a range of suppression systems that flood the room with an inert gas if a fire is detected. The inert gas smothers the fire and displaces any oxygen such that the fire can´t survive. Fire suppression systems are great for equipment but not for people. If there´s no oxygen then the ultimate effect is no human life. Fortunately, most systems provide a visual and auditory warning for people in the room that they need to get out or die.

_ **UPS Battery Charging:** Data centres need to run during power supply shortages so owners consider a range of options to supply immediate needs power to keep operating. Depending on the size of a centre, uniteruptable batteries are kept in banks for the use in an emergency. Nowadays we seldom use a lead acid batteries because of the production of significant volumes of hydrogen during the charging process from lead acid batteries. We do however use a range of sealed batteries like AGM that also produce hydrogen but generally at a lower rate. These batteries can increase in hydrogen output particularly in times of high-rate charging, like immediately after they have discharged. The problem with hydrogen is that it has a relatively low flash point and can produce a significant explosion is ignited. While we don't have smokers, we may have a range of switchgear or other electrical appliances that could just help that hydrogen explode. By having a battery charging room assessed against a hazardous area classification standard, we can ensure that the probability for a explosion is diminished significantly.

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_**Heat:** Apart from the normal fire risk, the management of heat in a data centre is critical to keeping the rack cool and operating within their specifications for performance. When heat is not managed, no only does the rack hardware suffer, so does the individuals inside the centre. Most cooling systems are built for a range of ambient temperatures and sometimes have difficulty in coping on those hot days so it is important to identify any outliers in terms of heat.

_**Noise:** Data Centres run a range of air conditioning, switchgear routers and servers that when combined together can produce significant noise levels above threshold values for safe communication and exposure to prevent noise induced hearing loss.

By having and effective plan for monitoring and control of noise in a data centre, owners can mitigate long term health effects in employees and contractors and lessen the probability of a future litigation.

_**Arc Flash:** Most data centres utilize a lot of power in order to keep their machines running. In order to get the power to the rack data centres must transform High Voltage input power to Low Voltage to supply equipment. Obviously, there is energy loss (as well as heat build-up) in the transformation of HV to LV so centres want to avoid step down like the plague.

Unfortunately, the use of HV and, in some cases LV, may result in scenarios where an arc flash hazard is present. Arc flash may occur when several electrical conductors are placed close to each other, with significant fault currents flowing through them. When this occurs, ionization of the air can take place as a result of various factors – such as differences in potential- which leads to a low resistance path and allows current to flow through the air gap between conductors.

There are a range of scenarios where arc flash resistant clothing and rescue procedures may be appropriate. Data Centre managers must ensure a program exists around arc flash protection and that appropriately trained & qualified personnel inspect centers on a regular basis to identify arc flash issues.

_**Fuel Storage and Handling:** Most data centres rely on a range of alternative energy supplies to keep the wheels spinning and while UPS is great for a short-term outage, most large centres install generators to ensure continuity of supply. The safety complication arises from risks in fuel storage and handling systems that supply power generation equipment. Significant quantities of stored fuel may require classification of the site under Dangerous Goods or workplace Health & Safety regulations and present risks for building owners in the event of a fire.

Maintainers of generation equipment must be vigilant in ensuring the efficacy of fuel lines and hosing. By situating generators close to air handling systems the risk of a building contaminated with diesel particulates or asphyxiants is highly likely.

By mapping out the process and risk with generator operation, Data centre manages can ensure the safety of their sites without compromising operational efficiencies.

Data center health hazards / Chemical Exposures: Maintainers in data centres usa a cocktail of chemicals for cleaning purposes however in a range of centres, cooling tower chemical may also be stored and decanted.

Data centre managers must evaluate all chemicals coming to site to ensure that the risk of exposure to site personnel are lessened and that the co-location in incompatible chemical cannot result in increased site fire hazards. Across Australia, obligations for minimizing exposure to hazardous substances are well defines and Data Centre Managers should aim to understand the what why how where and when of chemical use is occurring at their centre.

Work at heights: If the Data Centre has high racks, it will be no doubt that the staff or the visitors will be up and down ladders which inherently increases the risk of falls. Worse if it has maintenance contractors back and forward on site there´s a high probability that they will be on roof tops or climbing down the side of buildings. The data centre must have a system for limiting work at heights to trained and competent people.

4. How does your project plan ensure that someone is responsible for preparing a safe work method statement for the high risk project activities?

Duty Holders: A person conducting a business or undertaking (PCBU) carrying out any high risk work in connection with a construction project is required under the Work Health and Safety Regulation 2011 (WHS regulation) to:

_Ensure that a safe work method statement (SWMS) is prepared before the proposed work starts

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_Make arrangements to ensure that the high-risk construction work is carried out in accordance with the SWMS

_Ensure that a copy of the SWMS is given to the principal contractor before the work starts

_ Ensure that a SWMS is reviewed and revised if necessary

_ Keep a copy of the SWMS until the high-risk construction work is completed

All duty holders involved in a high-risk work activity must make sure:

_ The work is carried out in accordance with the SWMS

_ If the work is not carried out in accordance with the SWMS, the work is: stopped immediately or as soon as it is safe to do so, and resumed in accordance with the statement.

The primary purpose of a SWMS is to help supervisors, workers and any other persons at the workplace to understand the requirements that have been established to carry out the high-risk construction work in a safe and healthy manner.

The SWMS sets out the work activities in logical sequences, identifies hazards and describes control measures.

A SWMS should also include the following information:

_The PCBU´s name, address and ABN (if they have one)

_Details of the person(s) responsible for ensuring implementation, monitoring and compliance with the SWMS

If the work is being carried out at a construction project:

_The name of the principal contractor

_The address where the high risk construction work will be carried out

_ The date the SWMS was prepared and the date it was provided to the principal contractor.

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Workers and their health and safety representatives should be consulted in the preparation of the SWMS, if there are no workers engaged at the planning stage, consultation should occur with workers when the SWMS is first made available to workers, for example, during inductions training,or when it is reviewed sich as during workplace-specific training or a toolbox talk.

As Pacific Internet Solutions we will take care of the high-risk construction of the data center and will secure a group of highly qualified people to ensure that the SWMS is prepared before the work begins. We will agree with the group of people in charge of the construction the content of the SWMS, since they better understand the work that must be carried out and we can ensure together with them that the SMWS is implemented, monitored and revised correctly.

We must also prepare a generic SWMS for work activities that are carried out on a regular basis. This type of SWMS will be refined over a number of years to come which may include consultation with workers and other companies. To carry out these activities this SWMS will be reviewed to ensure that it applies to high-risk construction work and to the actual workplace.

To ensure that the SWMS will be applied correctly, we will carry out certain agreements and protocols that will include the following:

_ A system of routine or random workplace inspections (for example asking workers and supervisors a few questions about the control measures used in the SWMS to see if they understand what has to be done)

_ If the work is not being carried out in accordance with the SWMS:

. The work must stop immediately or as soon as it is safe to do so

. Work must not resume until the work can be carried out in accordance with the SWMS.

_ If work is stopped, the work and the SWMS should be reviewed to identify non-compliance and ensure the method in the SWMS is the most practical and safest way of doing the task.

_ PIS will not commence high risk construction work unless the principal contractor has been provided a copy of the SWMS.

The group of people in charge of the construction will ensure that all workers who are involved in high-risk construction are provided with the corresponding information and instructions.

The SWMS will be maintained and available for inspection until the last high-risk construction is complete.

5. What types of safety measures would expect to see in a safe work method statement for the following risks:

_**Electrical safety**: There are a range of scenarios where arc flash resistant clothing and rescue procedures may be appropriate. Data Centre managers must ensure a program exists around arc flash protection and that appropriately trained & qualified personnel inspect centers on a regular basis to identify arc flash issues.

. Prevent all potential contact with live electrical current: The best way to stay safe is to stay away from electrical hazards. Unqualified personnel should not interact or come close to electrical currents greater than 5OV.

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. De-Energize equipment and use lockout/tagout: Exposed, live electrical parts must be de-energized before work on or near them is permitted. Prevent accidents and isolate electrical energy by locking and tagging out the electrical system or parts of the system according to the company´s loc out-/tagout policy.

. Ensure safe use of electrical equipment: Employees should take care to handle electrical cords properly:

. Always unplug cords by pulling on the plug head, rather than the cord
. Do not press or overstretch electrical cords
. Do not fasten cords with staples
. Do not hang electrical equipment from cords

_ **Materials handling:** The handling of materials is essential in the industry, since it is essential to optimize processes, reduce cost and reduce risk. Here are some basic principles of material handling.

. Planning principle**:** Be clear objectives and functional specifications of the proposed methods.

. Standardization Principle: Equipment, controls and software must be standardized within the limits that achieve global performance objectives without sacrificing flexibility, modularity and production.

. Ergonomic Principle: Human capabilities and limitations must be recognized to ensure safe and effective operations.

. Unit Load Principle: The unit loads must be of the appropriate size and be configured according to which they achieve a material flow and the inventory objectives at each stage of the supply chain.

. Space Utilization Principle: Effective and efficient use of available space must be made.

. System Principle: Material movement and storage activities must be fully integrated to form an operating system that encompasses reception, inspection, storage, production, assembly, packaging, unification, order selection, shipping, transportation, and claims handling.

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. Automation Principle: Material handling operation should be automated where possible in order to improve operational efficiency, increase responses improve consistency and predictability, and lower operating costs.

. Environmental Principle: The environmental impact and energy consumption must be considered criteria when selecting equipment for handling materials.

. Life cycle cost principle: Develop a comprehensive economic analysis that takes into account the entire life cycle of material handling systems.

_ **Physical hazards:** Of all the hazards in the workplace environment, physical hazards might the least obvious. Anything in the environment that can cause a bodily harm can fall under the category of physical safety hazards. Environmental dangers include: Radiation, high exposure to sunlight/ultraviolet rays, temperature extremes (hot and cold), constant loud noise.

Once the identified physical hazards are identified, it is important to reduce risk posed to the employees.

Engineering controls reduce risk through physical means. These are some examples:

. Providing safety equipment to employees that reduces their exposure to the physical safety hazards.

. Reduce noises and vibrations present in the workplace.

. Place barriers between employees and physical hazards such as radiation or microwaves.

. Provide proper ventilation and air conditioning for employees.

. Insulate any surfaces that could be prone to extremes in temperature.

Administrative controls reduce risk by changing work processes and activities to make them safer. Some examples of administrative controls for physical safety hazards include:

. Handling smaller quantities of dangerous and reactive chemicals

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. Spending less time in areas of exposure

. Working away from noise when possible

. Providing employees with rest breaks away from physical hazards

. Training employees to recognize and avoid physical hazards

_**Height:** Working at heigh refers to any work where a person could potentially fall and injure themselves. A ladder, a roof´s edge, an opening on the floor, and even a loading dock can be considered working at height. Here are ten safety tips to help mitigate the risk of working at height.

. Use railing: Railing is a form of passive protection, the easiest and most recommended way to keep workers safe while achieving compliance.

. Select the proper PPE: All full-body harnesses that meet ANSI standards will perform the same, despite their cost. Sometime, a more expensive harness costs more simply because it´s been made to be more comfortable.

. Inspect the PPE: Harnesses and lanyards need to be inspected annually, if not more frequently, by a competent person. However. PPE should be inspected by the user prior to every use.

. Use ladders properly: Ladders lie at the source of many industrial and workplace accidents simply because we take their use for granted. Before using a ladder, consider whether or not they are the best solutions for the task. Then make sure the employees are trained to properly use a ladder.

_**Lifting:** Here is a list for safely lifting and moving material:

. Maintain the correct posture: avoid bending over and keep lifts close to the body.
. Lift in a careful, deliberate manner and avoid any sudden lift movements.
. Never lift materials from a sitting position, or twist to pick up a heavy object.
. Use the correct grip on objects; lifts should be shoulder high and with full grasp of the hands.
. Get assistance from co-workers to avoid successive lifts of heavy objects.

. Always make use of conveyors, slides or other devices, to avoid unnecessary lifting or pushing of objects.
. Always go around a blocked pathway, never step over an obstacle while carrying material.
. Maintain a clear line of site; objects should not block vision; lift only where there is sufficient lighting.
. Whenever possible; reduce load sizes, adjust bulky objects to ease movement.
. Regularly stretch back and leg muscles during the day and keep in good physical shape.

Submission requirements

1. The written tasks must be completed on a word processor and uploaded to the learning portal. You must clearly indicate which question each answer relates to.
2. All files must have your name in the file name.
3. You must click the 'Submit' button.