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От проектирования к эксплуатации ЦОД: типичные ошибки

Константин Королев

Директор по развитию бизнеса, Россия и СНГ

Классификация Tier:

Tier I: Basic Capacity

(Базовый набор компонентов инфраструктуры)

Tier II: Redundant Components

(Резервирование всех активных компонентов, в т.ч. накопителей энергии)

Tier III: Concurrently Maintainable

(Возможность обслуживания любого элемента без остановки работы)

Tier IV: Fault-Tolerant

(Сохранение работоспособности после любого единичного отказа)

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Трехуровневая сертификация по уровням Tier I…IV:

Сертификация по стандарту Uptime Institute Tier Standard: Topology

Этап 1. Проектная документация (Design Documents, TCDD)

Этап 2. Построенный объект (Constructed Facility, TCCF)

Сертификация по стандарту Uptime Institute Tier Standard: Operational Sustainability

Этап 3. Эксплуатационные практики (Operational Sustainability, TCOS)

Проведено более 2500 сертификаций в 110 странах мира

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НАША ОБЩАЯ ЗАДАЧА:

ПОСТРОИТЬ ЦОД ТАК, ЧТОБЫ ОН ВЫПОЛНЯЛ СВОЮ ОСНОВНУЮ ФУНКЦИЮ: РАБОТАЛ ВНЕ ЗАВИСИМОСТИ ОТ ПЛАНОВЫХ И ВНЕПЛАНОВЫХ ОСТАНОВОК

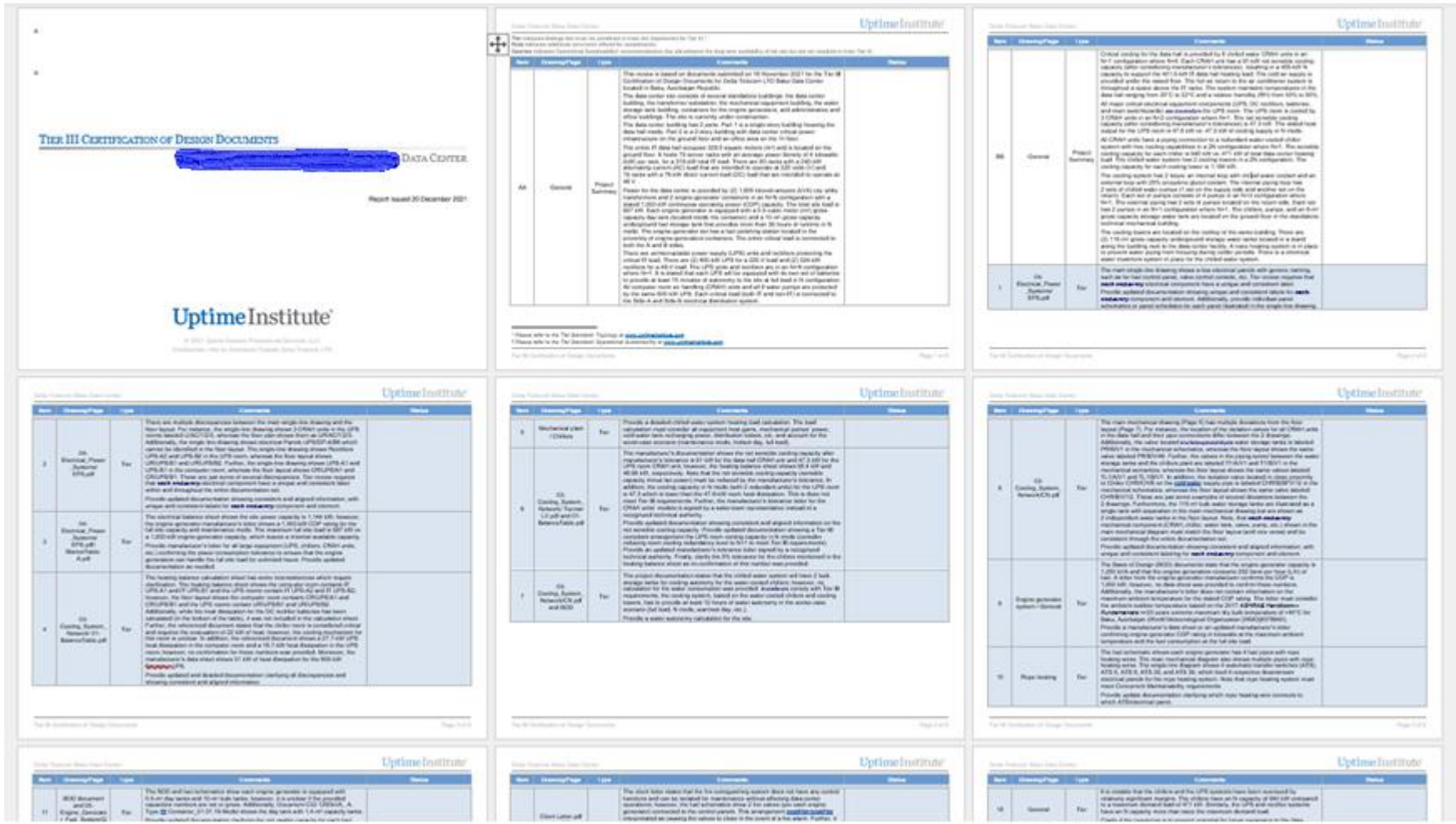
ПОДВЕРЖЕННОСТЬ ПЕРЕБОЯМ В РАБОТЕ ЗАВИСИТ КАК ОТ НАДЕЖНОСТИ САМИХ СИСТЕМ, ТАК И ОТ ЭКСПЛУАТАЦИИ ЦОД

ЧАСТЬ 1. НАДЕЖНОСТЬ ИНФРАСТУКТУРЫ, ИЛИ О ПРОЕКТИРОВАНИИ КАК ТАКОВОМ

- **Любые недостатки, огрехи, ошибки и неоптимальные решения в проекте способны свести на нет надежность объекта**

- **95% всех ошибок проявляются на этапе проектирования**

Анализ проектной документации в примерах



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Ошибка №1. Несоответствие требованиям стандарта

8	Item 3 - Floor Plan of All Critical Spaces Equipment Arrangement	Tier	A layout illustrating the location of all power cable routes has been submitted as part of the project documentation; however, there is no color-coding or any other method of clear identification for A and B power paths. Moreover, it is not fully clear if proper service access is available to the power cables. Provide confirmation that ***each and every*** power distribution component can be isolated and removed for maintenance without the need to remove complementary distribution paths or components so that at least N power and cooling are available during any maintenance operation to meet Concurrent Maintainability requirements.	
12	Item 4 - Electrical Schematics & Single Lines Diagrams	Tier	The single-line diagram shows main Switchgear (РУ-0.4) and the ГРЩ electrical panels as sectioned single panels. Concurrent Maintainability requirements must be applied to ensure that each panel section can be de-energized and isolated for maintenance/replacement without any issues. For such panels, provide a detailed drawing to demonstrate the intersection of the panel isolation. Confirm there are no transit communication cables or bus bars coming through the panel sections that could prevent the removal of a selected panel section.	

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Ошибка №2. Уникальность и консистентность маркировки элементов на чертежах

1	04-Electrical_Power_Systems/EPS.pdf	Tier	The main single-line drawing shows a few electrical panels with generic naming, such as for fuel control panel, valve control console, etc. Tier review requires that ***each and every*** electrical component have a unique and consistent label. Provide updated documentation showing unique and consistent labels for ***each and every*** component and element. Additionally, provide individual panel schematics or panel schedules for each panel illustrated in the single-line drawing.
	Item 3 - Floor Plan of All Critical Spaces Equipment		There is inconsistent labeling for the chillers' dry coolers. They are labeled as DC1 and DC2 in some documents, while other documents list them as EC-01A and EC-01B or as ДР1 and ДР2. Moreover, labeling for some other critical cooling components is missing from the floor layout. In addition, the hydro-modules are labeled as HM2.1/HM2.2 and ГМ1.1/1.2 (connected to the critical electrical panels)

Ошибка №3. Некорректный расчет электрических и тепловых нагрузок или его отсутствие

			The heating balance calculation sheet has some inconsistencies which require clarification. The heating balance sheet shows the computer room contains IT UPS-A1 and IT UPS-B1 and the UPS rooms contain IT UPS-A2 and IT UPS-B2; however, the floor layout shows the computer room contains CR/UPS/A1 and CR/UPS/B1 and the UPS rooms contain UR/UPS/B1 and UR/UPS/B2.
	Item 4 - Electrical Schematics &		A power load calculation has been submitted; however, there are multiple mistakes and inconsistencies. For instance, according to the power load calculation chart, the full data center load is 1,426 kW, whereas the single-line drawings show the load in Switchgear Section 1 as 1,651 kW. This does not meet Tier III criteria as N engine-generator capacity is only 1,440 kW (continuous rating). If the load
17	Item 10 - Mechanical Load Calculations	Tier	Additionally, for Room #18 (the energy center), it is unclear how the equipment heat gains have been calculated. Only final number are presented, with no explanation as to how the calculation was performed.

Ошибка №4. Некорректный учет климатических особенностей региона

20	DX cooling system	Tier	It is unclear how the DX systems will work during winter. For instance, the switchgear room (РУ-0.4) CRAC units have a 12-kW stated cooling capacity (it is currently unclear whether this is the gross, net, or net sensible capacity) with a limiting Freon pipe length of 7 meters (m) and allowable outside temperatures between -15°C and +43°C. A similar issue exists for the CRAC units in the energy room, with a DX condenser minimum allowable temperature of only -20°C. Provide an explanation as to how all critical DX systems can start and operate at the ambient extreme low temperature of -42°C. Further, provide a floorplan showing the DX system piping connections from the indoor units to the external outdoor components to confirm Concurrent Maintainability of ***each and every*** distribution path. Confirm that the DX system piping length and height difference will not impact the cooling capacity for all DX systems (if applicable).

Ошибка №5. Performance tolerance (допуски производительности оборудования)

3	04-Electrical_Power_Systems/ EPS.pdf/ BlanceTable-A.pdf	Tier	The electrical balance sheet shows the site power capacity is 1,144 kW; however, the engine-generator manufacturer's letter shows a 1,000-kW COP rating for the full site capacity and maintenance mode. The maximum full site load is 997 kW vs a 1,000-kW engine-generator capacity, which leaves a minimal available capacity. Provide manufacturer's letter for all large equipment (UPS, chillers, CRAH units, etc.) confirming the power consumption tolerance to ensure that the engine generators can handle the full site load for unlimited hours. Provide updated documentation as needed.
6	03-Cooling_System_ Network/ Tecnair LV.pdf and 01-	Tier	The manufacturer's documentation shows the net sensible cooling capacity after manufacturer's tolerance is 91 kW for the data hall CRAH unit and 47.3 kW for the UPS room CRAH unit; however, the heating balance sheet shows 95.4 kW and 48.96 kW, respectively. Note that the net sensible cooling capacity (sensible capacity minus fan power) must be reduced by the manufacturer's tolerance. In addition, the cooling capacity in N mode (with 2 redundant units) for the UPS room is 47.3 which is lower than the 47.6-kW room heat dissipation. This is does not meet Tier III requirements. Further, the manufacturer's tolerance letter for the CRAH units' models is signed by a sales team representative instead of a recognized technical authority.

Ошибка №6. Несоответствия в описании используемых элементов, оборудования, компонентов и пр., или отсутствие описания

30	General	Tier	The project description document states that there are 10 rows of racks inside the IT data hall and each row contains 12 racks with 2 power connections, for a total of 120 racks. However, according to the electrical diagrams, each row has 13 racks with 2 power connections, which gives a total of 130 racks. Clarify the discrepancy and provide an updated documentation set accordantly.
11	Electrical schema; Uptime English	Tier	The main single-line diagram shows (2) 400-kW UPS for Side-A and for Side-B. However, the Basis of Design (BOD) document (Page 3) states the UPS system has a capacity of 800 kVA/760 kW. Clarify (and confirm with manufacturer's documentation) the UPS output power, in kilowatts, for both mechanical UPS and IT UPS systems.
12	General/ electrical	Tier	UPS battery information was not provided. Clarify the UPS battery configuration, connection, runtime, and charging power calculation and also verify this ride-through time is sufficient to support the maximum load while the engine generators start and close into the critical bus.

Прочее:

А. Не усложняйте

18	03-Cooling_System_Network/CN.pdf	Operate	The main mechanical schematics show multiple valves which appear to be redundant. For instance, Valves aT2BFV/28, T2BFV/29, and T2BFV/13 and T2BFV/14, T3BFV/13, T3BFV/14, T3BFV/14, CHR/V/6, CHR/V/11, CHR/V/2, PR/V/11, PR/V/6, PR/V/14, and a few others.
			While these valves are not required to meet Tier III requirements, consideration should be given to removing these valves to save some costs against any operational impact.

Б. Не будьте формалистами и используйте здравый смысл.

Да, 28+1 – тоже Tier III.

ЧАСТЬ 2.
НЕСКОЛЬКО СЛОВ О «СФЕРИЧЕСКОМ КОНЕ», ИЛИ ЛЮБОЙ ПРОЕКТ МОЖНО ИСПОРТИТЬ, БЫЛО БЫ ЖЕЛАНИЕ

ЗДАНИЕ ДОЛЖНО СООТВЕТСТВОВАТЬ ЗАДАЧЕ

ПРИНИМАЙТЕ В РАСЧЕТ ХАРАКТЕРИСТИКИ И ЗДАНИЯ, И ОБОРУДОВАНИЯ

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НЕ УСЛОЖНЯЙТЕ. КОМУ-ТО ЭТО ОБСЛУЖИВАТЬ

КОГДА РАЗМЕЩЕНИЕ ОТДЕЛЬНЫХ СИСТЕМ ВХОДИТ В КОНФЛИКТ

НЕ СТРОЙТЕ ЗВЕЗДОЛЕТ В ЯКУТИИ

ЧАСТЬ 3. ДАЖЕ САМЫЙ НАДЕЖНЫЙ ЦОД МОЖНО УГРОБИТЬ НЕГРАМОТНОЙ ЭКСПЛУАТАЦИЕЙ

ПЕРСОНАЛ – САМЫЙ ВАЖНЫЙ АКТИВ ЦОД

2 основные причины неприятностей:
– кто-то сделал то, что не нужно
– кто-то не сделал то, что нужно

Важно учесть:

- **Достаточность персонала**
- **Устройство рабочих смен**
- **Объем переработок**
- **Обучение персонала**

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ФОРМАЛИЗУЙТЕ ВСЕ ПРОЦЕССЫ И ПРОЦЕДУРЫ

- Опишите существующие процессы
- Зафиксируйте порядок исполнения всех процедур, штатных и аварийных
- Обеспечьте доступность информации для персонала
- Проводите тренировки по выполнению различных действий

ПОМНИТЕ ПРО ТЕХОБСЛУЖИВАНИЕ

- Постройте модель технического обслуживания
- Проводите плановое обслуживание своевременно
- Отслеживайте отложенное обслуживание
- Не пренебрегайте предиктивным обслуживанием
- Следите за состоянием ЗИП
- Формализуйте отношения с партнерами

ПОСЛЕСЛОВИЕ

1. Стройте ЦОД сообразно задачам. Tier 0 – тоже вариант.
2. Не увлекайтесь ни новаторством, ни консерваторством
3. Формируйте и включайте в процесс службу эксплуатации уже на этапе проектирования
4. Уделите самое пристальное внимание эксплуатации ЦОД
5. Привлекайте к работе профессионалов

Спасибо за внимание

Вопросы?

kkorolev@uptimeinstitute.com

+7 916 642 6603