ICW Water Leak at FCC

Forces a Partial Computing Outage at Feynman Computing Center

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Leak Detected by Monitoring

- A leak was detected 0618 on Thursday, May 31, 2007
- The source was the main ICW water pipe in the east utility area of the Feynman Computing Center
- Assessment was initiated and at 0745, email was sent to CD management & stakeholders to advise them of a probable outage

End Cap on 8” Incoming ICW

The end cap had deteriorated and water was spraying out on the floor. There was concern that at any time the pressure could increase the size of the rupture and velocity of the leak

Affected Computing Equipment

- The ICW water is required for cooling by the CRACs (Computer Room Air Conditioner) in the computer rooms and the air conditioning for the offices
- There was potential impact on core servers (email, web, networking, storage, databases, Scientific computing and BSS financials)

Understanding the impact

- By mid-morning, the working estimate forecasted a three hour outage, starting at 1300
- Stakeholders were advised and the list of critical systems was refined
- Stakeholders prepared plans to shutdown non-critical systems and to be ready to start up later in the day

Deploying The Plan

- It was calculated that if non-critical systems in FCC computer rooms were shutdown that critical services would be able to remain up for the three hour outage
- Most computing on FCC1 was shutdown, networking and core servers on FCC2 remained up

Deploying The Plan

- Stakeholders were formally advised at 1137 that the outage would be from 1300 to 1600
- All CD employees were advised about the outage in FCC computer rooms and offices and requested to turn off non-essential power devices
- Stakeholders advised customers of affected services

During the Outage

- Work on the water leak commenced at 1300. The weather was overcast and roughly 80F
- Some investigation and action was required for a few instances of non-essential computing that remained up
- At 1520, email was sent out revising the outage estimate to 1700 – 1800. Temperatures remained moderate except in the east end of FCC2 where networking and core servers reside

Critical Decision Point

- At 1600 (4:00PM), a Management decision was made to shutdown all systems as the temperature around core servers had risen significantly
- Shortly thereafter, a firm estimate of completing the work was provided (~1700)
- The ICW was restored at 1705. Cooling was re-started. FCC1 computing systems started coming back up at 1715 and FCC2 at 1725

Near Miss?

- Most of the Networking and Core Services remained available throughout
- Some key services did go off line as equipment was shutdown or failed
- Services that were not high availability were down for approximately 4-6 hours
- Much effort was spent to keep vital core services available and to manage the other services

Lessons Learned

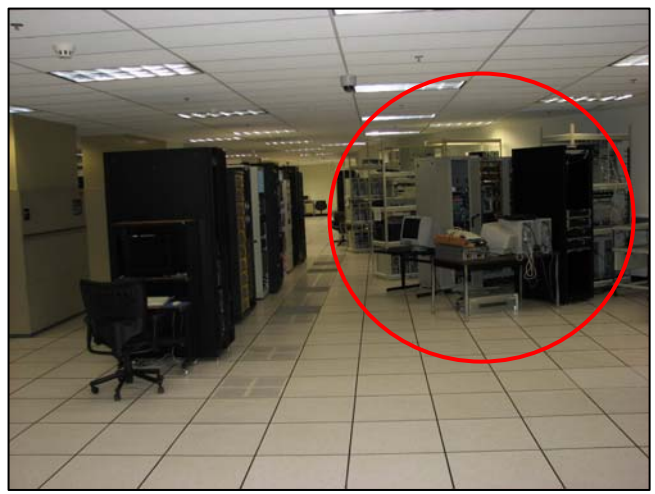
- Feynman Computing Center ICW supply is a **high risk** single point of failure. A failure in the main or lack of water to FCC can take down the cooling in the building for days
- This risk is exacerbated by the aging infrastructure and water pipes which are 20+ years old

Lessons Learned

- Requiring non-critical systems to be powered down 60-90 minutes prior to the outage allows the CRACs to eliminate the residual heat
- All non-critical systems need to be powered down prior to the outage
- Having Networking and Core Servers centralized together created hot spots. Physical distribution would allow systems to remain up longer with reduced cooling

Hot Spots on FCC2

- Core Servers are grouped together (top photo)
- Test systems in lower photo (right side) produce warm air in direct proximity to the intake of Core Servers



Hot Spots on FCC2

- Considerable density in the Networking area creates a hot spot
- Notice the 60kva UPS in the lower photo produces extra heat

Risk Mitigation – Portable Chiller

- FCC water infrastructure has four flanges in the 8” pipes that allow for the connection of one or two portable chillers
- The logistics of renting a generator and chiller requires 24-48 hours and significant funding (having a PO in place)
- Guarantee of faster delivery requires additional funds (not regarded a viable strategy)
- Implementation of such a plan requires tremendous coordination between many roles and probably is best for ICW outages that can be planned and anticipated

Risk Mitigation – Portable Chiller

- There are two scenarios
- 1) A 100 ton chiller connected to house power or portable generator (480V@300A) to provide chilled water for five CRACs (4 on FCC2 AC-13, 14, 15, 16 and 1 on FCC1 AC-17). These five CRACs (four on the west side of FCC2) are not ideally located to serve Core Servers and Networks

Risk Mitigation – Portable Chiller

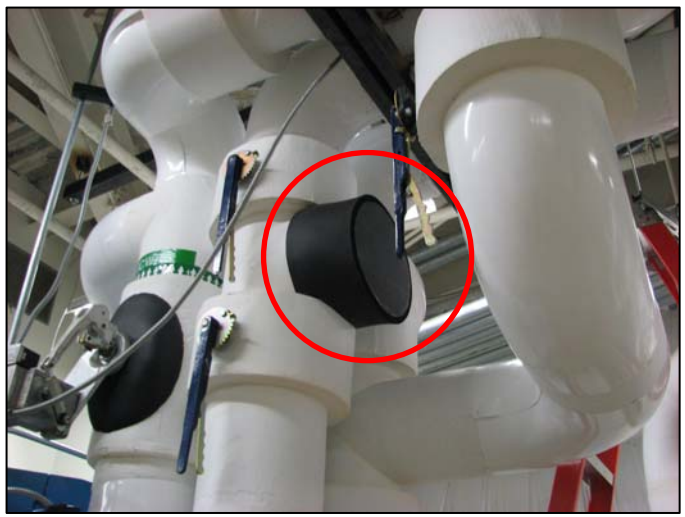
- 2) Two 100 ton chillers could be connected to serve the entire FCC building, including the DX and CW CRACs. Requires portable generators for chillers 480V@300A X 2
- Either scenario is best suited for scheduled multi-day extended outages

Risk Mitigation – Portable Chiller

- Shown are the flanges to connect an external chiller for the Chilled Water CRACs
- Electric Panel 480V@350A

Risk Mitigation – Portable Chiller

- Covers of the flanges to 8” pipes for the connections to provide cooling to the entire building shown to the right



Risk Mitigation – Portable ACs

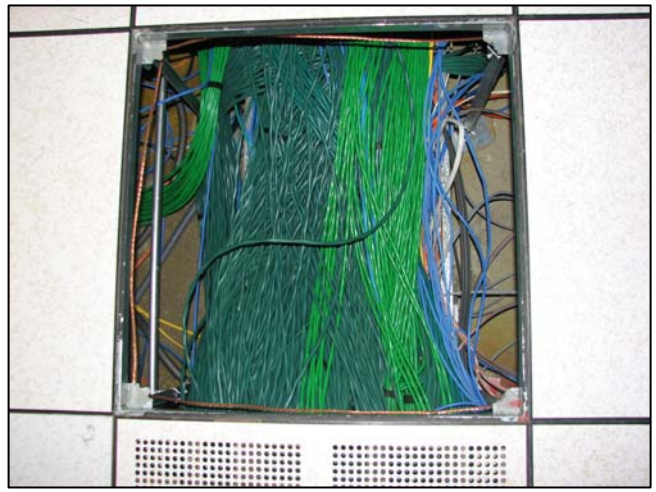
- Consideration has been given to portable air conditioners
- Emergency delivery would need to be understood as standard delivery is 24-48 hours minimum
- There are many safety considerations, large number of stakeholders involved and significant logistics coordination

Deployment of Portable ACs

- One portable 30 ton AC would require 480V@100A and 3-20” hoses. FCC2 cooling output of 8 CRACs is 144 tons
- Removal of FCC2 windows in the computer room would be required to allow for the 20” air hoses to pass through

Impaired Air Flow

- Distribution of the cold air from portable ACs could be a problem (lower CFM and localized distribution)
- Circulating cool air under the floor is impaired by years of cabling and other obstructions



Final Comments On The Outage

- Feynman Computing Center ICW supply is a **high risk** single point of failure that is capable of causing an outage for more than 24 hours, affecting the Laboratory's core services (Networking, Email, Web, Databases, Scientific Computing, BS Financials, etc.)

Recommendation

- Elimination of the root cause issue – the dependency on ICW for cooling the Feynman Computing Center
- Replace the end of life fleet of DX and CW CRACs (Computer Room Air Conditioning) units with liquid refrigerant CRACs
- Address issue of very limited FCC cooling capacity which restricts future growth by providing adequate cooling using modern cooling strategies, equipment and controls

FESS Reports

- Project Definition Report - FCC CRAC Replacement Study. FESS/Engineering Project No. 10-5-57. September 28, 2007
- Project Definition Report - FCC1E Computer Room Upgrades. FESS/Engineering Project No. 10-5-53. June 9, 2006