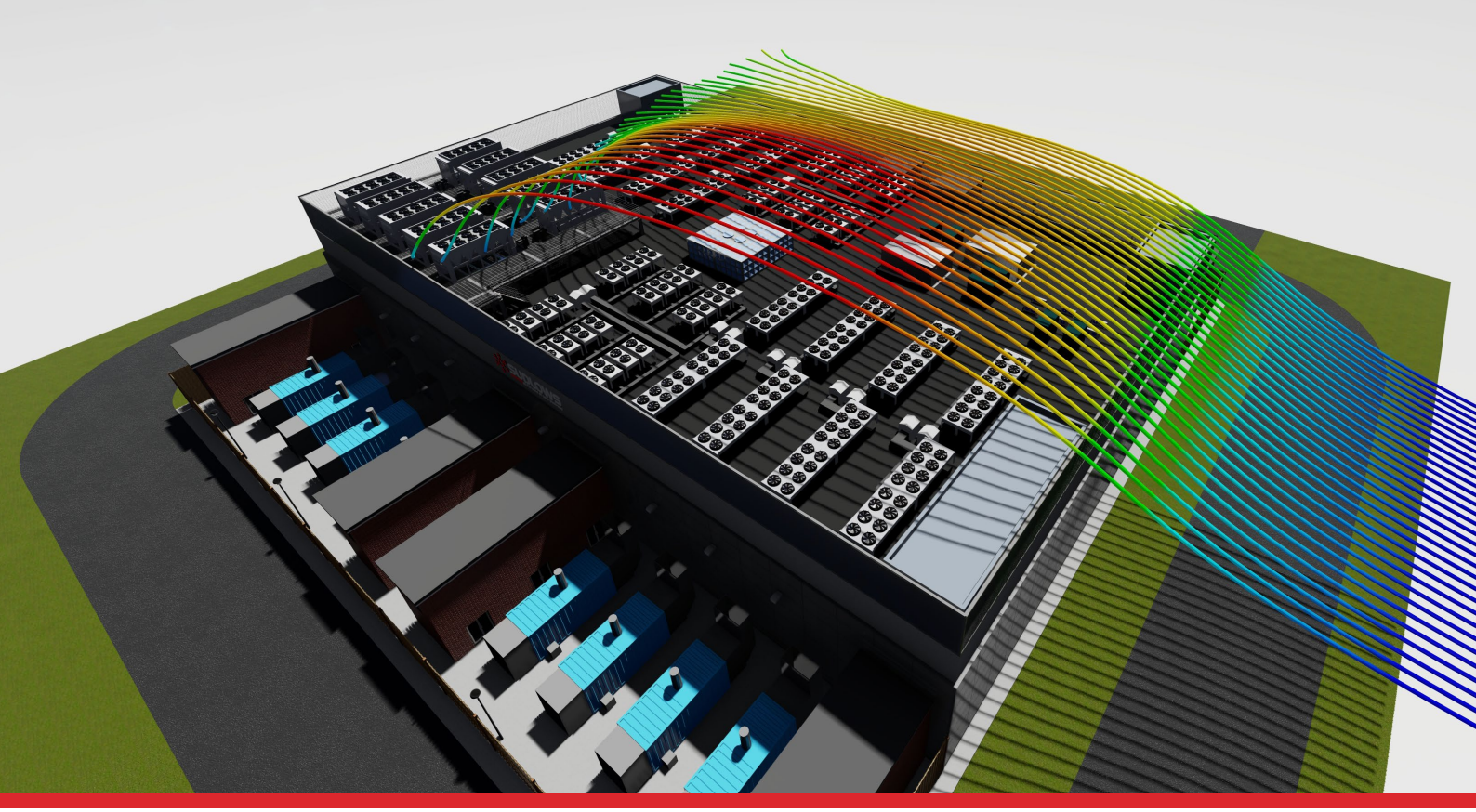


Rooftop Airflow Management

Case Study

Overview

Sudlows have been appointed to assess and validate the external airflow and heat rejection for a growing number of large data centre facilities. Many of the facilities assessed use low rise, large area buildings with rooftop mounted heat rejection systems and several reoccurring issues are found which are common to buildings of this configuration. Using an iterative results driven design process, Sudlows ensured that the systems operated within specification under all external conditions.

Sudlows' Simulation and Modelling Team identified the root cause of the anticipated heat rejection issues and worked closely with the external client team to identify and assess potential solutions, including modifications to the layout, site design, building and plant selection.

Multiple scenarios and configurations were modelled allowing the team to identify a solution which achieved the client's requirements with the lowest impact to build cost and programme.

The Brief

The client had developed a whole site design for a large facility, which incorporated a large rooftop plant area for cooling and equipment. This ensured efficient use of the land purchased while maintaining architectural aesthetic and reduced noise transmission to the nearest neighbour.

The building's rooftop featured a high density of heat rejection systems over a large span. Following initial discussions, Sudlows were appointed to undertake the required modelling, simulation and analysis to validate the equipment's performance under local weather conditions, considering both extreme operation at peak ambient temperature and coincident sustained wind conditions.

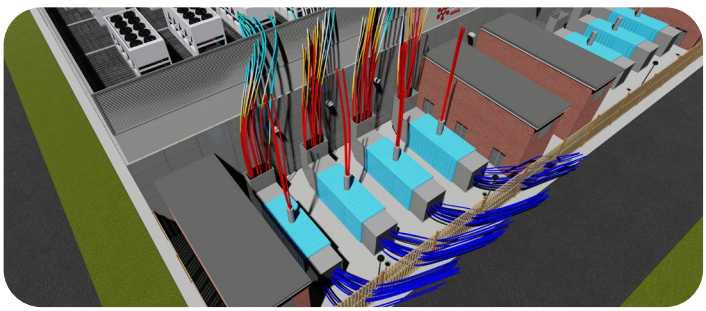
Vertical components of velocity where strong downward flow (blue) is observed at the point of reattachment of the boundary layer and between condenser discharges within the constrained flow region, indicating high levels of recirculation due to starvation of supply air from below

Initial Modelling and Simulation

Sudlows' Specialist Simulation and Modelling Team, part of the Critical Infrastructures division, processed the provided client data, building models and plant data sheets to develop a full site model consisting of building architecture and relevant M&E plant.

Simulations were progressed based on different combinations of external temperature and wind velocity, and different M&E operating conditions including with and without on-site power generation systems operating.

The initial design was processed, and several issues were identified where heat rejection equipment was found to be operating outside of specification. The cause of failure was identified as a combination of the entrainment of generator radiator exhaust flow into critical cooling systems, and the separation and re-attachment of the boundary layer associated with air flow over the building, causing local regions of high external pressure on critical components and the development of micro-environments with very high levels of recirculation.



Interaction of Critical Power Systems with Critical Cooling Systems

Subsequent Analysis and Solution

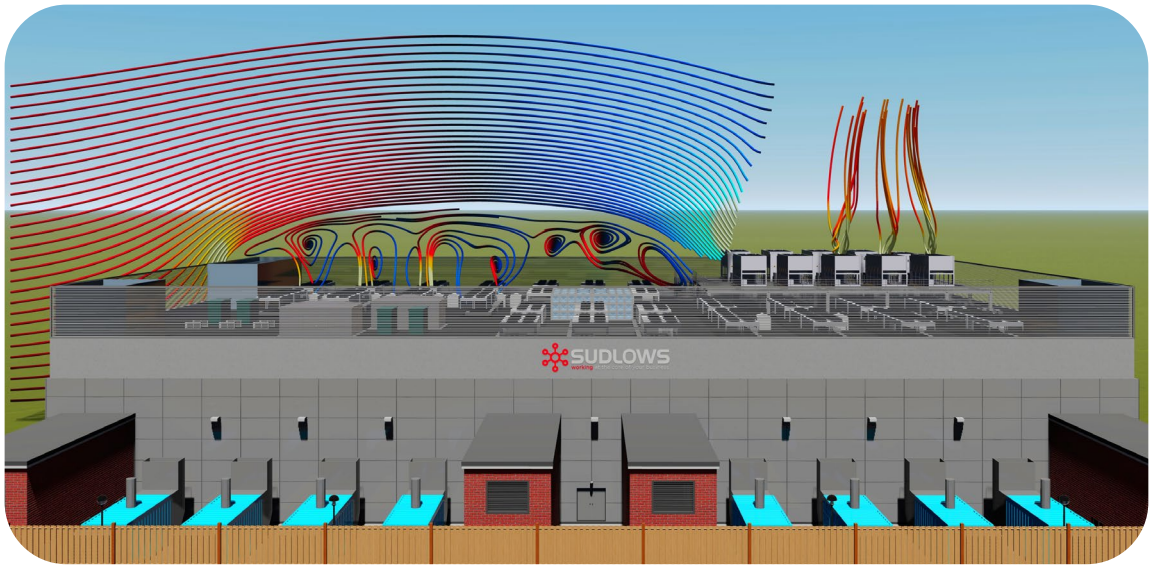
Following the initial results, Sudlows were appointed to undertake a range of investigations, considering methods of mitigation and assessing of the anticipated performance of each proposed adjustment. Over 30 configurations were reviewed before a final solution was found, and in co-ordination with the full client team, a configuration was recommended for implementation which considered the performance, cost of implementation and impact to build programme to ensure a highly optimised solution.

Applicability to Other Projects

This project is applicable to a wide range of clients due to issues which are frequently found in the use of low rise, large area buildings. This building type is common in the deployment of large data centre facilities in some geographic regions.

The performance impact caused by the interaction with external air flows highlights the requirement for early assessment of proposed plant layouts against the external design conditions. Because this project was assessed during the design stage, issues were able to be identified prior to construction, avoiding the cost and complexity of retrofit mitigation measures once deployed.

It is also useful to note that facilities in geographic regions with particularly high ambient temperatures are impacted further due to the reduced relative buoyancy of exhaust air streams.



Flow streamlines from the prevailing wind direction clearly show a constrained region of flow developing at the condensers (left) and a concentrated downward flow at the initial chillers (right)

Identifying Design Issues with CFD

This type of design problem is well suited to analysis with CFD tools, due to the ability to simulate extreme and specific weather scenarios at a building scale which would not be possible to test on-site.

Within the simulation environment we can assess the impact of external air flows forming boundary layers on the rooftop and surrounding walls. The resultant air flow pattern can cause vortices that trap rejected heat, as well as causing strong downdraughts at the point of reattachment pushing exhausted heat back into the compound, and adding high levels of external static pressure onto individual areas of equipment which would otherwise not have been anticipated.

Sites with strong prevalent wind conditions are expected to be affected worst by this effect while sites with dry bulb temperature extremes of 35°C provide additional cause for concern, as there is both a reduced capacity to tolerate recirculation and a reduced buoyancy components of the exhaust air.

In addition to the ability to model and assess the impact of ambient temperature and wind conditions, the methods used allow for changes and updates to be rapidly verified in the future. For example, additional equipment, changes in running conditions, and alterations to the surrounding geometry including both planned expansion of client sites, and neighbouring redevelopment and construction outside of the control of the client.

Sudlows' Simulation and Modelling Team

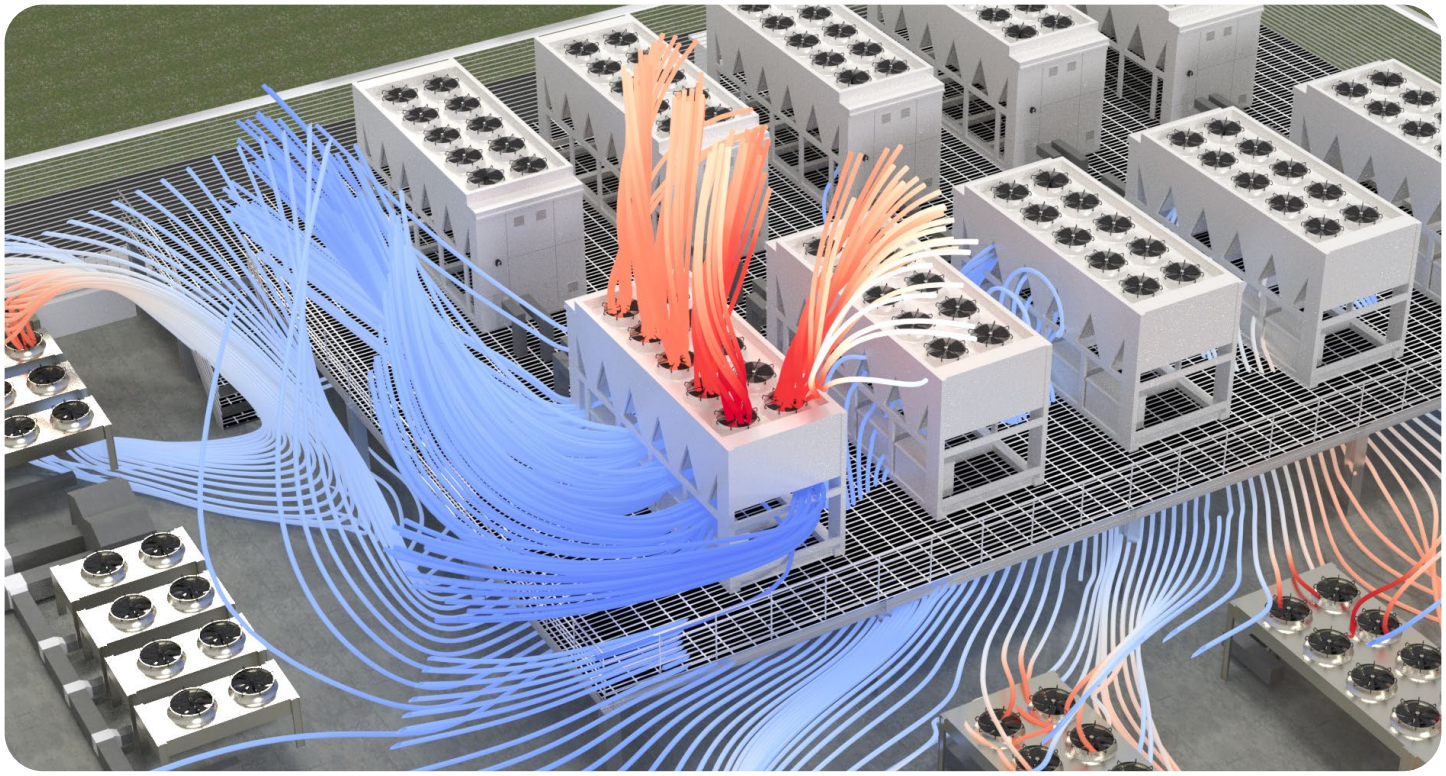
Sudlows' Simulation and Modelling Team was established to find the answer to a number of reoccurring engineering challenges that many of our clients were encountering.

With an extensive experience of data centre specific CFD analysis, our team assist with a wide range of engineering services including Design Validation, Optimisation, Root Cause Analysis, Transient Studies, and Large External Simulations as shown within this case study.

Our team use the latest theoretical computational methods and physical hardware to ensure that large scale, complex problems are able to be assessed with speed and accuracy.

We support some of the largest facility operators globally, to ensure that issues during and following construction are avoided through comprehensive simulation and analysis within an often fast paced and demanding design programme.

Temperature plane through the heat rejection systems displaying high levels of recirculation where equipment air flow is constrained or hindered by the air flow over and around the building



Key Capabilities

- Parallel Studies of different Operating Conditions, Scenarios and Configurations.
- Assessment of Normal Operating Conditions and Performance, Plant Failure Conditions, Power Failure Conditions, and Extreme External Weather Conditions.
- Assessment of proposed upgrades and changes to local geometry including impacts from neighbouring developments.
- Engineering appraisal of all results and findings, in addition to raw data and results of pass/fail criteria.
- An Experienced Data Centre Design Team to ensure continued support for client teams in finding practical and effective solutions to projects and issues identified.

For further information, to discuss any requirements you have, or to find out how Sudlows' Simulation Team would be able to help with any issues and challenges faced by your sites or designs please get in touch either by email at hello@sudlows.com or by phone on 0800 783 5697.

Land Size:
40,000m^2

Computer Spec:
35 million mesh cells across 72 CPUs

Project Duration:
3 weeks

Contact:
hello@sudlows.com
or 0800 783 5697

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