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Occupational Disease in the Data Centre: What the Literature Tells Us About Cancer, Organ Disease, Hearing Loss, and the Aggravating Role of the Environment

Data centres are not clean rooms. They are complex industrial environments combining high-intensity noise, carcinogenic chemical exposures, pathogenic biological hazards, extreme thermal gradients, continuous ergonomic demand, and psychosocial stress — all within a single building, often occupied around the clock. This review examines the published medical and occupational health literature on the documented and plausible health impacts on DC workers, organ system by organ system, and asks what environmental factors may be aggravating them.

Clinical Review · DC Occupational Health Risk Management Series |

Cross-reference: DC-OH-MSP-001 · DC-OH-RMR-001 · Sections 03–07

PREFACE A Note on the Evidence Base

No large-scale, DC-specific epidemiological cohort study has yet tracked the long-term health outcomes o centre workers as a defined occupational population. This is an important limitation: the industry is tively young, grew explosively in the 2000s, and its workforce diversity — from NOC operators and elec engineers to HVAC technicians and forklift drivers — resists simple categorisation in occupational health regis What the literature does provide, however, is a rich body of evidence on each of the specific hazard exposure are present in the DC environment, derived from comparable industrial populations: night shift workers, wo exposed to diesel exhaust, noise-exposed industrial workers, workers in thermally demanding environments, tenance workers at cooling towers, workers handling refrigerants and chemical cleaning agents, and intensive puter users. Applied carefully to the DC context, this evidence base is both substantial and clinically actionable

Throughout this review, IARC evidence classifications are used where applicable: IARC GROUP 1 = definite huma cinogen IARC 2A = probable IARC 2B = possible LIMITED EVIDENCE = suggestive but not confirmed. Clinical act warranted across all categories.

01 Cancer Risks in the Data Centre Workforce

1.1 Night Shift Work and Circadian Disruption

The most significant and best-evidenced cancer risk in the data centre environment does not arise from any c cal or physical agent. It arises from the work schedule itself. The International Agency for Research on Cancer ated night shift work in 2007 and reaffirmed its classification in 2019: IARC 2A — a probable human carcinoge the basis of sufficient evidence in experimental animals, strong mechanistic evidence, and limited but positiv dence in human epidemiological studies for cancers of the breast, prostate, colon, and rectum.

The biological mechanism is well characterised. Light exposure during the biological night suppresses mela production by the pineal gland, disrupts the central circadian pacemaker in the suprachiasmatic nucleus, de lates circadian clock genes involved in cell cycle control, and produces chronic low-grade immune dysregulati the DC context, Network Operations Centre operators and shift engineers are exposed to this hazard continuou working under artificial lighting at all hours, with no circadian cue from natural light, in a building deliberate signed to exclude external environmental rhythms. IARC 2A

A 2023 update of the epidemiological literature on night shift work and breast cancer, published in *Annals of Exposures and Health*, found that across six cohort and four case-control studies published after the 2019 IARC e tion, there was continued support for an association between persistent, long-duration, or high-frequency shift work and elevated breast cancer risk, particularly in pre-menopausal women. The magnitude of assoc across studies ranged from modest (RR approximately 1.1) to substantial (RR approximately 1.6 for long-du shift workers). As Erren and Lewis note, disrupted chronobiology in the occupational setting may contribute s cantly to the population cancer burden — with an estimated one in five workers worldwide exposed to this pro carcinogen. For a facility running 24/7/365, that figure applies to a large proportion of the entire DC workforce.

1.2 Diesel Exhaust and the Generator Room

The diesel generators that are integral to every Tier III and Tier IV data centre represent a second, chemical fined carcinogenic exposure. Diesel engine exhaust (DEE) was reclassified by IARC in 2012 from Group 2A (prol to IARC GROUP 1 — definitively carcinogenic to humans — on the basis of sufficient evidence of lung cancer causat human epidemiological studies, principally the Diesel Exhaust in Miners Study (DEMS) and two trucking inc cohort studies encompassing over 12,000 heavily exposed workers.

A quantitative meta-regression by Vermeulen et al. (2014), published in *Environmental Health Perspectives*, deriv cess lifetime lung cancer mortality risks from three independent occupational cohorts. The study estimated cess lung cancer deaths per 10,000 workers at lifetime occupational exposure of 1 μg/m^3 elemental carbon — a readily achievable during generator testing and emergency operation in enclosed plant rooms — rising to 200 e deaths per 10,000 at 10 μg/m^3 cumulative exposure. The authors concluded that DEE at levels common in oc tional settings poses excess lifetime lung cancer risks substantially above the acceptable limits of 1 per 1,000 u Europe and the United States. IARC also notes limited but positive evidence for an association with **bladder c** at the Group 1 classification level. The key DC exposures are generator weekly test runs, emergency generatio ing grid failure, and loading bay diesel vehicles accessing the goods-in area.

1 in 5
WORKERS WORLDWIDE EXPOSED TO IARC GROUP 2A CARCINOGEN (NIGHT SHIFT WORK)
IARC Monograph Vol.124, 2019

200
EXCESS LIFETIME LUNG CANCER DEATHS PER 10,000 AT 10 MG/M³ DIESEL ELEMENTAL CARBON
Vermeulen et al., Environ. Health Perspect., 2014

~6%
ESTIMATED FRACTION OF GLOBAL LUNG C DEATHS ATTRIBUTABLE TO DIESEL EXHA
Vermeulen et al., 2014

1.3 Environmental Aggravators of Cancer Risk

A critical but often overlooked dimension is the interaction between occupational exposures and environment tors that may aggravate carcinogenic risk. For DC roof-level maintenance staff — who may conduct weekly chec cooling towers, generator exhaust stacks, and AHU equipment — ultraviolet radiation (UV) is a direct carcino co-exposure. UV radiation (specifically UVA and UVB) is classified as IARC GROUP 1 for skin cancer causation, incl squamous cell carcinoma, basal cell carcinoma, and cutaneous melanoma. Roof-level workers in sunny climat during extended summer maintenance periods, may accumulate substantial UV doses, particularly to the fore neck, and face — body regions often inadequately protected by standard occupational PPE, which is not design UV protection. No sun protection programme is documented in any data centre OH framework reviewed in the ing literature.

Additionally, the co-exposure of shift work's immune suppression with carcinogenic chemical exposures (dies frigerant degradation products) may represent a synergistic risk not captured by any individual hazard assess The chronobiological research strongly suggests that circadian disruption impairs DNA damage repair mechan which would logically enhance the carcinogenicity of concurrent chemical exposures. This interaction has n been directly studied in DC populations, but the mechanistic basis is well established.

02 Respiratory Disease: Lung, Airways, and Suppression Agent Exposure

2.1 Diesel Exhaust and Lung Function

Beyond its carcinogenic classification, DEE produces acute and chronic respiratory effects well below the ca genic threshold. Studies of truck drivers and other DEE-exposed workers have documented decreased peak e tory flow, increased airway resistance, cough productive of phlegm, throat and eye irritation, and exacerbati asthmatic symptoms at occupational concentrations of 75 µg elemental carbon/m^3. Chronic low-level exposure sociated with accelerated decline in FEV_1, the clinical marker of obstructive lung disease progression. DC wo involved in generator testing and maintenance — typically 30-minute weekly runs under load — require ba spirometry and annual follow-up.

2.2 Refrigerant Exposure and HF Inhalation

HVAC and refrigeration engineers working in data centres are regularly exposed to HFC and HFO refrigeran 134a, R-410A, R-32, R-1234ze). In their intact form, these are primarily asphyxiants — acting via oxygen displace in confined spaces. However, when refrigerants contact hot surfaces or fire — as occurs during a fire event in a room — thermal decomposition produces hydrogen fluoride (HF) and other acid gases. Acute HF inhalation a centrations above 5 ppm (NIOSH IDLH: 30 ppm) causes severe pulmonary oedema, potentially delayed by hours after apparent recovery. Chronic low-level exposure to intact refrigerant vapour has not been clearly linl chronic lung disease, but skin defatting and occupational contact dermatitis are documented consequence Section 5). O_2 depletion monitoring is mandatory in all refrigerant handling areas; the clinical standard is ala <19.5% and evacuation at <18% O_2.

2.3 Fire Suppression Agent Exposure

Modern data centres use clean agent gas suppression (FM-200, Novec 1230, CO_2) in server halls. Inadvertent a tion — which does occur during false alarms and equipment malfunction — can expose occupants to these agen fore evacuation. CO_2 at concentrations above 5% causes respiratory distress and loss of consciousness; above death within minutes from asphyxiation. FM-200 (HFC-227ea) is acutely asphyxiating at high concentration produces HF on thermal decomposition. Novec 1230 (FK-5-1-12) has a lower occupational health profile in form, but regulatory bodies in several jurisdictions have noted insufficient long-term inhalation toxicity data occupational health exposure pathway from false activation is under-documented in the published literatur represents a genuine surveillance gap.

ENVIRONMENTAL INTERACTION: INDOOR AIR QUALITY AND WILDFIRE SMOKE

AHU systems draw external air into the data centre. In regions with poor ambient air quality — increasingly com mon due to wildfire smoke events (classified as PM2.5 fine particulate, a known respiratory carcinogen at high exposure), vehicle traffic pollution, or industrial emissions — DC workers may be exposed to a complex mixtur of airborne toxicants unless AHU filtration and damper systems are rigorously maintained. MERV-13+ filtration is required as a minimum. During wildfire smoke events (AQI >150), automatic damper closure is advisable, with CO_2-base recirculation management.

This is an emerging environmental health risk as climate change increases the frequency and geographic reach of wil fire events. DC facilities in the western United States, southern Europe, Australia, and southern Africa are now routine affected by extended periods of poor ambient air quality that standard DC ventilation designs were not engineered to address.

03 Noise-Induced Hearing Loss and Tinnitus

Hearing loss is one of the most robustly documented occupational health outcomes in the data centre environ and one of the most practically neglected. The persistent high-frequency "whoosh" of server cooling CRAC/CRAH units, precision air conditioning systems, and generator plant creates a continuous broadband environment that is psychologically normalised by workers — making it particularly insidious from a preve perspective.

Audits by the Antea Group Health and Safety team have measured sound pressure levels exceeding 85 dB server hall areas regularly. Direct measurements in server rooms by Alnuaimy and Shushura (2022), published proceedings of the Emerging Technology Trends conference, found that average noise levels around server reach up to 92 dB(A), with peak levels within server rack enclosures reaching up to 96 dB(A). Both the N Recommended Exposure Limit (85 dB(A) over 8 hours) and the OSHA PEL (90 dB(A) over 8 hours) are frequent ceeded during routine server hall maintenance work — which may involve sustained presence in these env ments for periods well beyond the safe exposure duration at these sound levels.

The clinical consequence of sustained noise exposure at these levels is well established. NIOSH has determine significant noise-induced hearing loss (NIHL) occurs at the OSHA PEL over a working lifetime, and at the NIOSI (85 dB(A)), an 8% excess risk of developing occupationally significant hearing loss exists after 40 years of lifetin posure. NIHL is irreversible — there is no surgical or pharmacological treatment that restores cochlear hair once damaged. The characteristic audiometric signature is a 4 kHz notch — a specific dip in hearing thresho 4,000 Hz that precedes the broader high-frequency loss associated with ageing, allowing early detection if annu diometry is performed. Co-exposure to ototoxic chemicals (solvents, certain refrigerant degradation products produce a synergistic adverse effect on hearing beyond that predicted by noise alone.

Tinnitus — persistent subjective noise in the ears, described as ringing, buzzing, or hissing — is a common manifestation of noise overexposure, and may precede measurable audiometric threshold shift. Data centre wc with tinnitus symptoms should trigger immediate audiometric assessment and review of noise exposure cor The psychological burden of tinnitus, including sleep disturbance and elevated anxiety and depression scores, pounds the psychosocial hazard profile already present in shift-work populations.

92–96 dB(A)
MEASURED SOUND LEVELS IN SERVER RACK AREAS — WELL ABOVE NIOSH REL OF 85 DB(A)
Alnuaimy & Shushura, 2022; Antea Group audits

100%
OF NIHL CASES ARE PREVENTABLE — AND ZERO ARE REVERSIBLE O
ESTABLISHED
CDC/NIOSH, 2024

04 Musculoskeletal Disease: Spine, Upper Limb, and Whole-Body Load

4.1 Display Screen Equipment Workers — NOC and Office Populations

Work-related musculoskeletal disorders (WMSDs) are the most frequently reported occupational disorders v
wide, and the data centre's NOC, DCIM control rooms, and office populations are not exempt from this globa
den. A landmark study published in *Occupational Medicine* (Oxford Academic) by Woods (2005), conducted sp
cally in data processing workers, found that **86% of data processors reported musculoskeletal pain or discomf
the previous year**, with the highest prevalence at the neck (58%), followed by the lower back, shoulders, and
limbs. Visual strain symptoms were reported by 47% of participants. Critically, the study found that psycho
factors — job dissatisfaction, low task control, insufficient time to complete work — were independently asso
with musculoskeletal symptom reporting, reinforcing the multi-factorial causation model for WMSDs in inte
computer work environments.

A 2024 systematic review published in *ScienceDirect* confirmed that among computer user populations, the p
lence of WMSDs ranges from 33.8% to 95.3%, with the lower back, neck, upper back, and shoulders as the mo
fected regions. Prolonged computer use, repetitive motion, awkward posture, and psychosocial pressures su
workload and job control are consistently identified as risk factors. For NOC operators who may work 12-hour
toring shifts with minimal postural variation, the cumulative spinal and upper limb loading is substantial.

4.2 Technical and Logistics Workers — Manual Handling and Vibration

Data centre technicians performing rack-and-stack operations (installing, removing, and repositioning se
which typically weigh 15-30 kg per unit and must be handled in confined rack spaces with awkward postures)
sent a distinct manual handling risk group. Forklift operators and goods-in personnel face whole-body vib
(WBV) exposure — now regulated under the EU Physical Agents (Vibration) Directive 2002/44/EC — and repe
manual handling of heavy equipment consignments. The evidence base on WBV is unambiguous: sustained oc
tional WBV exposure is causally linked to low back pain, disc degeneration, and an increased risk of lumba
prolapse. Hand-arm vibration (HAV) from power tools used in maintenance tasks is associated with hand-arm
tion syndrome (HAVS) — a combination of peripheral vascular dysfunction (vibration white finger, Raynaud's
nomenon), peripheral neuropathy, and musculoskeletal dysfunction — for which there is no effective treatment
the vascular component is established.

4.3 Environmental Aggravation of MSK Disease

Cold environments aggravate musculoskeletal conditions by reducing soft tissue extensibility, increasing musc
cosity, and impairing proprioceptive feedback — all of which increase injury risk during manual handling. Colc
temperatures in some data centres, particularly those running at elevated efficiency setpoints, can approach 10
Workers entering cold aisles from ambient temperatures without adequate warming are at elevated MSK injury
particularly for low back and shoulder strains during handling tasks. This environmental interaction is n
dressed in any existing DC safety guidance reviewed by Prime OH Intl. The occupational health implication is
quirement for a cold-aisle thermal transition protocol: adequate warm-up time, appropriate layering where
aisle dwell times exceed 20 minutes, and restriction of heavy manual handling immediately following cold expo

05 Skin and Dermatological Disease

Occupational contact dermatitis (OCD) represents the most common occupational skin disease globally, and se DC-specific chemical exposures constitute genuine skin hazard pathways. HVAC and refrigeration engineers dling glycol-based heat transfer fluids, biocides used in cooling tower water treatment (quaternary ammonium pounds, isothiazolinones, glutaraldehyde), alkaline cleaning agents, and dielectric oils used in transforme high-voltage equipment maintenance are exposed to a range of dermal sensitisers and irritants. Isothiazol preservatives — widely used as biocides in water treatment — are among the most frequent causes of occupa allergic contact dermatitis in the EU, with a well-documented dose-response relationship. Glutaraldehyde, use disinfectant in cooling tower systems, is a potent occupational sensitiser and has been associated with occupa asthma in exposed workers.

Battery maintenance staff in UPS and emergency power systems may be exposed to sulfuric acid mist (from fl lead-acid batteries) and lithium-containing compounds (from Li-ion battery handling), both of which cause ir contact dermatitis and, with chronic exposure, chemical burns. Electrical engineers regularly handling PVC and insulation materials may be exposed to phthalate plasticisers and lead stabilisers (in older cable types), have endocrine-disrupting and potential carcinogenic properties at high chronic exposures.

The environmental dimension is again relevant: roof-level workers during summer months combine chemica mal exposure with UV irradiation, which can dramatically increase photosensitisation reactions from certai cides and photodegradation of refrigerant residues on skin. Pre-employment and annual skin assessment is a cal requirement for Groups D and E workers.

06 Renal, Cardiovascular, and Metabolic Disease

6.1 Thermal Stress and Renal Injury

The data centre presents a thermal stress paradox: server hall workers moving between cold aisles (10-15°C) ar aisles (up to 45°C) within minutes. The hot aisle exposure is the clinically dominant concern. The published l ture on occupational heat stress and renal disease has grown substantially over the last decade, driven initia the epidemic of chronic kidney disease of non-traditional origin (CKDnt) in agricultural workers in Central Am and now expanded to multiple industrial settings.

A systematic review published in *Frontiers in Public Health* (2023) confirmed a consistent body of evidence li high indoor and outdoor temperatures with adverse renal outcomes in workers through three pathways: therm ulatory failure with cardiovascular fatigue, dehydration with progressive kidney dysfunction, and direct th tubular injury. Repetitive heat exposure with dehydration is associated with acute kidney injury (AKI) that, wh current, may progress to CKD. A cross-sectional study published in the *Journal of Occupational Health* (2024) marised evidence of heat-related renal calculi formation, AKI, and long-term renal impairment, noting that wo in high-heat industrial zones had a 9% prevalence of renal calculi. The American Journal of Physiology publis narrative review in 2021 confirming that heat stress induces tubular kidney injury, worsened by higher core te atures, dehydration, longer work durations, and muscle-damaging exertion.

6.2 Shift Work and Cardiovascular / Metabolic Disease

The cardiovascular and metabolic consequences of night shift work are among the best-documented outcomes cupational medicine. The WHO has identified shift work-related circadian disruption as a significant risk fact metabolic syndrome, type 2 diabetes, hypertension, and ischaemic heart disease. Physiologically, the mecha include disruption of insulin secretion rhythms (leading to glucose intolerance), elevated cortisol and inflamm cytokines during night wakefulness, sympathetic nervous system activation in the absence of natural day/nigh monal transitions, and altered dietary patterns (high-calorie, irregular-timed eating) during night shifts. A WHO fact sheet on heat and health confirms that heat extremes can worsen cardiovascular and diabetic cond and cause acute kidney injury — the heat exposure from hot aisles may therefore interact synergistically wi pre-existing cardiometabolic vulnerability of long-term shift workers.

In the DC context, the NOC population working rotating or permanent night shifts represents a cohort that shou monitored annually for: blood pressure (grade 1 hypertension or above), fasting lipids, HbA1c and fasting gl (pre-diabetes and diabetes screening), BMI and waist circumference, and electrocardiographic changes — which are documented outcomes of long-term night shift employment and none of which are routinely captu standard workplace health surveillance in this sector.

07 Biological Hazards: Legionellosis and Beyond

Every data centre with evaporative cooling towers carries a legally mandated Legionella risk. *Legionella pneum* — the causative agent of Legionnaires' disease — thrives between 25°C and 45°C, precisely the temperature maintained in cooling tower water circuits. The bacteria are transmitted by inhalation of contaminated ae generated by cooling tower drift, spray nozzles, or inadequately maintained AHU systems. OSHA reports ap mately 6,000 confirmed Legionnaires' disease cases annually in the United States, with experts estimating true dence of 8,000-18,000 hospitalisations per year — the difference representing underdiagnosis and misclassific as community-acquired pneumonia.

Occupationally, workers most at risk are those who sample, dose, clean, or otherwise directly maintain co tower water systems — precisely the Group E HVAC and water treatment engineers in the DC work Legionnaires' disease carries a case fatality rate of 5-15% in otherwise healthy individuals and up to 25% or hig immunocompromised persons. For DC workers with shift work-impaired immune function, this represents a vated risk at the individual level beyond that predicted from general population incidence rates. The occupa health standard requires a Water Safety Plan, routine microbiological monitoring of cooling water, Legionella ogy at pre-employment baseline and every two years, and immediate urinary antigen testing for any febrile i within 10 days of cooling tower work.

The environmental dimension: ambient temperatures above 30°C accelerate biofilm formation and Legionell liferation in cooling tower water, particularly during summer heat events. Climate change is predicted to inc both the frequency of extreme heat days and the geographic range of summer temperatures favourable to Legio growth. DC cooling tower maintenance staff therefore face an increasing biological exposure that is directly l to and aggravated by environmental temperature trends.

08 Psychosocial and Mental Health Consequences

The psychosocial dimension of data centre work is arguably the most under-surveilled health domain in this s NOC operators and shift engineers work in environments characterised by prolonged vigilance demands (mo ing hundreds of system parameters for anomalies), social isolation (particularly in small-team or lone-wo overnight scenarios), absence of natural light, disrupted sleep architecture, and the constant background awar that a missed alert could trigger significant commercial, reputational, or safety consequences. The psychiatri demiology of night shift work consistently identifies elevated rates of depression, anxiety disorders, burnout, a tigue-related cognitive impairment in shift-working populations compared to day workers, across multiple i tries and countries.

The published literature demonstrates that occupational heat stress has documented effects on mental healt yond its physical consequences. A review published in *PMC* (2023) noted that recurrent extreme heat exposure sociated with worse mental fatigue, higher aggression levels, and increased rates of suicidal ideation in occup ally heat-exposed populations. This finding — that a physical environmental exposure produces measurable ps atric outcomes — is particularly significant for server hall workers who move between extreme thermal env ments throughout their working day. The neurobiological mechanism involves heat-related disruption of serot gic and dopaminergic neurotransmission, affecting mood regulation and impulse control.

Cold-aisle exposure carries its own psychosocial dimension: the absence of thermal comfort, combined with levels that prevent normal conversation, creates a sensory environment that workers in prolonged mainte shifts describe as aversive and mentally taxing. The cumulative psychosocial burden — night shift dysphoria, mal discomfort, acoustic stress, vigilance fatigue, social isolation — represents a genuine occupational m health risk that is not captured by any existing DC-specific health surveillance framework.

> ***"86% of data processors reported musculoskeletal pain or discomfort in previous year. Visual strain was reported by 47%. Psychosocial factors low task control, job dissatisfaction — were independently associated w both outcomes."***
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> WOODS V., OCCUPATIONAL MEDICINE, OXFORD ACADEMIC, 2005

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09 Cold-Related Health Effects: The Under-Recognised Half of the Thermal Equati

While the heat hazard of data centre hot aisles receives attention proportional to its severity, the cold hazard o aisles and cold-aisle containment has received almost no published attention in occupational health literature. aisle setpoints in modern data centres, driven by PUE efficiency targets, can be as low as 18-21°C in the aisle with localised temperatures near floor-level cold distribution plenum outlets sometimes reaching 10-12°C. In in sion-cooled server deployments — an emerging technology — the dielectric fluid (a fluorinated compound or neered oil) may be maintained at temperatures as low as 15-20°C, requiring technicians to work with hands merged or regularly contacting cold fluid surfaces.

The occupational health consequences of repeated, prolonged cold hand exposure are well established: perip vasospasm (Raynaud's phenomenon), reduced manual dexterity (increasing the risk of fumbling in the manage of electrical connections and delicate hardware), and peripheral neuropathy with chronic exposure. The com tion of cold exposure and vibrating tools (used in server rack installation) synergistically increases the risk of I Cold exposure also reduces immune competence at mucosal surfaces — nose, throat, and upper respiratory tr increasing susceptibility to viral respiratory infections in workers who may already be immunologically co mised by shift work-related circadian disruption. In DC environments without adequate heating transition zon tween cold aisles and ambient work areas, there is no published evidence that any thermal transition protocol i tematically implemented.

10 Summary: Health Outcomes by Organ System and Environmental Interaction

DOCUMENTED OCCUPATIONAL HEALTH OUTCOMES IN DC-RELEVANT EXPOSURE GROUPS AND KNOWN ENVIRONMENTAL AGGRAVATING FACTORS

Organ / System	Documented Outcome	Primary DC Exposure	Environmental Aggravator	Evidence Level
Lung (cancer)	Lung cancer	Diesel exhaust (DEE) — generators, loading bay	Wildfire smoke (PM2.5); outdoor air pollution; indoor poor ventilation	IARC GROUP 1
Breast / Prostate / Colorectal (cancer)	Increased cancer risk (limited evidence in humans; sufficient in animals)	Night shift work — NOC, operations engineers	Light pollution (external night-time light at work/travel); dietary disruption	IARC 2A
Bladder (cancer)	Increased bladder cancer risk (limited evidence)	Diesel exhaust — generator maintenance, loading bay	Heat-induced dehydration concentrating urinary carcinogens	IARC GROUP 1 (LIMITED EVIDENCE)
Skin (cancer)	Squamous cell carcinoma, basal cell carcinoma, melanoma	Roof-level maintenance — UV exposure (unprotected)	UV intensity; climate change increasing UV index; heat amplifying photosensitiser reactions	IARC GROUP 1
Inner ear (cochlea)	Noise-induced hearing loss (NIHL), tinnitus	CRAC/CRAH fans, server fans, generator plant — 92–96 dB(A)	Co-exposure to ototoxic solvents; acoustic synergy with impulse noise events	Established (OSHA/NIOSH exceeded)
Cervical / lumbar spine; upper limbs	WMSDs, disc disease, CTS, tendinitis, RSI	Prolonged DSE use (NOC); manual handling (rack-and-stack, logistics); WBV (forklifts)	Cold exposure reducing soft-tissue extensibility; heat impairing neuromuscular response	Established (86% prevale in data processors — Wo 2005)
Kidney (renal)	Acute kidney injury (AKI), renal calculi, progression to CKD	Hot aisle thermal stress — dehydration, tubular injury	Heatwaves amplifying ambient temperature load; wildfire smoke (PM2.5 nephrotoxicity)	Consistent evidence (Frontiers in Public Health 2023; Chapman et al., Am Physiol, 2021)
Cardiovascular system	Hypertension, IHD, arrhythmia, metabolic syndrome	Shift work — circadian disruption; heat stress; arc flash injury (cardiac arrest)	Heat waves compounding cardiometabolic vulnerability; cold stress increasing cardiac demand	Consistent evidence (WH 2024; IPCC reports)
Lung (infectious)	Legionnaires' disease (life-threatening pneumonia)	Cooling tower aerosol — HVAC/water treatment maintenance staff	Warm ambient temperatures accelerating Legionella proliferation; climate change extending risk season	Established (OSHA; CCOH 8,000–18,000 US hospitalisations/year)
Skin (non-malignant)	Contact dermatitis (irritant and allergic); chemical burns	Biocides (isothiazolinones, glutaraldehyde), glycols, battery acid, dielectric oil	UV photosensitisation; heat increasing skin blood flow and dermal absorption	Established (EU-OSHA; E sensitiser classifications)
Respiratory (non-malignant)	Occupational asthma, COPD acceleration, chemical pneumonitis	Diesel exhaust, biocides (glutaraldehyde), fire suppression agents (FM-200/CO_2), refrigerant decomposition (HF)	Poor ambient air quality; wildfire smoke; cold air bronchoconstriction	Limited to established depending on specific ag
Mental health / CNS	Depression, anxiety, burnout, fatigue-related cognitive impairment	Night shift — circadian disruption; acoustic stress; vigilance demand; isolation	Heat-related mental fatigue and aggression; cold-related sensory aversion; light pollution at night	Consistent evidence (WH PMC 2023 review)

Organ / System	Documented Outcome	Primary DC Exposure	Environmental Aggravator	Evidence Level
Peripheral vascular / nervous system	HAVS, Raynaud's phenomenon, peripheral neuropathy	Cold-aisle exposure; power tools (HAV); immersion cooling fluid contact	Cold climate amplifying vasospastic episodes; cumulative vibration dose	LIMITED DC-SPECIFIC EVIDENCE — established in compara exposures
Lymphatic / haematopoietic system	Possible lymphoma and leukaemia — not DC-specific, plausible from shift work circadian disruption	Night shift — melatonin suppression, immune dysregulation	Co-exposure to immune-suppressing thermal and chemical stressors	IARC 2B / INSUFFICIENT EVIDENCE — under active investigat

11 Research Gaps and the Case for a DC-Specific Cohort Study

The evidence reviewed in this article, while substantial, rests entirely on inference from comparable occupa populations rather than direct DC-specific cohort data. This is a critically important limitation. The data c workforce is unique in several respects that may modulate risk: the simultaneous presence of multiple occupa hazards within a single facility (heat, cold, noise, chemical, biological, ergonomic, and psychosocial stressors produce interaction effects not captured by single-hazard studies in other industries; the specific cold-hot th cycling experienced by server hall workers has no direct analogue in any studied population; and the rapid e tion of DC technology (immersion cooling, liquid cooling direct-to-chip, AI workload density) is creating new sure scenarios — particularly for novel dielectric fluids — for which no occupational toxicological databas exists.

Prime OH Intl. advocates for the establishment of a multicentre prospective occupational cohort study of data c workers, following the precedent of the Diesel Exhaust in Miners Study, the Nurses Health Study (for shift work similar landmark occupational cohorts. The minimum dataset would encompass: baseline audiometry, spiron and biomarker panels; annual health outcomes surveillance; exposure quantification for noise (personal dosim chemicals (air and biomonitoring), thermal environments (WBGT and cold-aisle temperature logging), and work parameters; and linkage to national cancer registries. Without this evidence base, the health of the ap mately one million data centre workers employed globally in 2026 — a number growing rapidly — will continue managed by inference rather than evidence.

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