



CREATIVE, MODULAR AND SUSTAINABLE CLEANROOMS

Some industry sectors saw more cleanroom builds than others in 2013, with biotech, medical and packaging sectors enjoying the most investment in new facilities. Susan Birks looks at the trends and the growing demand for modular and flexible plants

Large-scale projects involving the build of permanent bricks and mortar were relatively few in number, but of the projects undertaken many pushed the boundaries of design, environmental control and sustainability to new levels.

The Pirbright Institute's 11,065m² laboratory facility for research into animal viruses in Surrey, UK, for example, is among the most advanced category 4 biocontainment facilities in the world. Shepherd Construction was a main contractor in the build and the contract included the most exacting requirements to achieve a very low air leakage rate of 0.0091 per m³/per m²/hr at +/-200 pascals, a massive 1100 times more compliant than the applicable building regulations at four times the pressure.

In terms of good design, Dutch architects EGM architecten and Royal HaskoningDHV showed that a new potent drug handling facility could be both architecturally beautiful and practical and have a high regard for safety. Built for the Erasmus Medical Centre in Rotterdam, the A15 hospital pharmacy consists of a production building with 1,900m² of cleanrooms and 400m² of labs, as well as offices and a separate warehouse. An important aspect of the design was allowing a large amount of daylight into

the interior, to contribute to employees' well-being. Large glass surfaces, wide corridors and long sightlines were also designed to stimulate communication and interaction among staff. A narrow construction site resulted in an elongated building, which optimises the production process. The box-in-box design created a corridor around the cleanrooms, providing a view of the production process without the need to enter the department.

Additional space was created for a services distribution floor above the cleanroom. This consisted of a walkable cleanroom ceiling spanning the entire cleanroom area for the distribution of all technical utilities with easy access to the grids and fittings of the rooms below. All central technical building services were located directly above this distribution floor. This design enabled all maintenance or repair work on technical components to be carried out from outside the manufacturing area, safeguarding the hygienic conditions in the cleanrooms, and during normal working hours rather than (expensive) evening or weekend hours.

Many recent builds have involved the repurposing of existing cleanrooms or facilities. This trend has accelerated as pharmaceutical multinationals have rationalised facilities and moved

EGM architecten and Royal HaskoningDHV designed and constructed a beautiful yet functional off-site hospital pharmacy building for Rotterdam's Erasmus Medical Centre

production to cheaper locations outside Europe. Some expansive facilities have been split up and repurposed into 'incubator bioparks' with smaller labs and facilities for emerging life science and biotech companies.

Active in the design and construction modular cleanroom systems, AES Clean Technology of Montgomeryville was appointed by US drugmaker NanoViricides to design and construct a cleanroom suite for a new laboratory and cGMP pilot production facility. This was built by renovating an existing 18,000ft² light manufacturing plant on a 4.2 acre lot in Shelton, CT, US. The cleanroom suite comprises the main cGMP manufacturing sections of the pilot plant and provides for Class 100 process scale laminar and chemical fume hoods, ISO 6 to ISO 8 work areas, plus entry airlock and egress systems.

In other sectors, recent market uncertainty has seen companies opt for smaller, cheaper, modular, reconfigurable and portable facilities. This has advantages in that most of the build is completed off-site, with plant and utilities

connection and validation being carried out on the company premises, saving on build times and costs and cutting business interruption.

French company Ertec unveiled a new modular cleanroom concept at the cleanroom show Contaminexpo in Paris. Called Cleanskid, this modular cleanroom is built onto a steel skid that can be craned into place, providing an ISO Class 5 to Class 7 environment for immediate use. The mini controlled environment has all the required features of a hygienic cleanroom – special flooring, crevice-free coving, flush windows and doors and lighting. It has electrical power connections ready to plug in and air handling units on the ceiling.

A new line of modular cleanrooms suitable for the demands of washdown environments was introduced by Clean Air Products, of Minneapolis, US. The CAP-583 stainless steel hardwall modular cleanrooms incorporate features that make washdowns faster, easier and more thorough, the firm says. The modular system also offers flexible sizing and multiple options to meet a variety of application needs and requirements from ISO Class 5 to Class 8.

The cleanrooms are constructed with corrosion-resistant, Type 304 stainless steel ceiling and wall panels. Double-wall construction protects wiring, plumbing and ducts from cleaning processes and all ceiling and wall panels are joined with Bio*Seal, a special silicon joint plug for secure, washable, watertight seals. Radius edges at wall and ceiling joints shed water for fast, easy cleaning. Return air ducts are designed with a sloped bottom surface for quick draining. The stainless steel doors and frames are integrated into the wall panels and use National Sanitation Foundation (NSF) approved hinges for easy cleaning.

Meanwhile, cleanroom contractor WISAG built a new modular cleanroom laboratory for a client within just four weeks. This module was installed at the Veterinary Clinic in Osterode am Harz, Germany, a laboratory producing cancer therapies for pets for the company PetBioCell.

The 50m² large container was assembled in the Dresden production facility of WISAG, then packed in an airtight manner and shipped by truck to Osterode. The cleanroom was equipped with high-quality metal walls, an HVAC system and Class A sterile workbenches to provide a sterile manufacturing area. Before entering the cleanroom, staff are able to change clothes, wash and disinfect



WISAG built this modular cleanroom facility for production of animal therapies at its facility in Dresden and then transported it by lorry to the client in Osterode

in the specially designed personnel entry/changing rooms.

The biotech and life science sectors have been among the most buoyant and require facilities that can deal with the particular containment issues posed by cell culture and the development of cell therapies. For example, the US University of Rochester Medical Center (URMC) opened a new stem cell facility that will enable researchers to create, study and use stem cells in early-phase experimental human therapies.

The 3,600ft² Upstate Stem Cell cGMP facility was created with US\$3.5m in funding and consists of three separate labs that can each support different cell production projects. Located in URMC's DelMonte Neuromedicine Research Institute, it is designed to be a multi-use cleanroom facility, with high flexibility and versatility, for the production of clinical grade therapeutics.

To meet cGMP requirements the facility incorporates several design features, including redundant air handling systems, walls covered with a fibreglass gel coat that aids in cleaning, and a building monitoring system that enables staff to check remotely air quality and room and equipment parameters 24 hours a day.

Growth in hygienic packaging areas

The packaging sector is seeing growing demand for cleanrooms. DS Smith Packaging, a UK supplier of corrugated packaging, opened a purpose-built facility at its Wellingborough plant in the UK for the packaging of foods, pharmaceuticals and electronics in a sanitised environment. It has BRC/IOP High Risk Global Standard food accreditation. Dominic Drew, Managing Director of DS Smith Packaging Sheet Plants, said the firm was seeing an increasing demand from food, pharmaceutical and electronic

manufacturers for packaging to be produced in this kind of environment.

In line with the company's carbon reduction commitment, the new building uses 192 solar panels that will generate sufficient energy for 50% of its total power consumption when at full capacity.

The new structure boasts a range of features to ensure hygiene integrity and minimise the risks of cross contamination, such as CleanTrax ProfilGate, a tyre and footwear cleaning system for removing dirt, dust and moisture from forklift wheels and footwear at factory entrances.

Material selection

Telstar's Jorge Nuero looked at the importance of the selection of materials and components for cleanroom construction, which is becoming increasingly complex due to the wide variety of options now available.

In his article, Nuero provided key considerations for optimising cost and ensuring safety and quality. He noted that the traditional building methods of constructing the walls and ceilings on site from raw materials, followed by the applications of a PVC or epoxy finish coating, are rapidly being replaced by the use of modular elements of self-supporting, factory-made sandwich panels. This transition has occurred due to the many advantages offered by the use of modular elements.

Many companies offered new wall systems in 2013. PortaFab added a new lightweight framed wall system to its FabLine series. The FabLine Framed LT series offers similar functions to the firm's current product line, but it weighs and costs less.

Designed for microelectronic and nanotechnology applications that require extensive bulkheading around tools, this system features vertical and horizontal members that are easily connected to each other. The design simplifies construction and provides airtight seals around equipment for minimum loss of room

pressurisation. The US firm, based in Chesterfield, MO, says the wall system offers several advantages, including high durability, design versatility and simplified installation.

French company Arclynn, a supplier and installer of cladding and panels, offered a new range of smooth, impervious, non-absorbent, easy-to-clean composite panels suitable for use in cleanroom and hygienic environments.

The panels have specially modified surfaces with a reduced level of ridges (down to the nanoscale) which help to resist the adhesion of bacteria. The white panels of composite resin are hydrophobic, bacteriostatic and ideal for hygienic environments. They can be fitted into new or refurbished buildings.

In the US, Puracore says its aluminium honeycomb cored panel is one of only a couple in the world to have obtained the new FM 4882 approval. To meet the FM 4882 criteria, the panel had to pass the FM 4880 standard fire test, the ASTM E84 test and a 16ft high parallel panel test. FM 4882 is a new standard that tests the interior wall and ceiling materials or systems for smoke-sensitive occupancies.

Meanwhile Fulcrum Composites, a US-based manufacturer of cleanroom wall panels, offered a new range of curved panels designed to provide seamless rounded corners in drywall installations. Curve Panels are installed in the same way as drywall but bridge the gap between small radius vinyl trim and the smallest radius that is possible to bend in conventional drywall. Once installed the wall is completely seamless making it suitable for cleanroom use.

Saint-Gobain Ecophon, a supplier of sound-absorbing ceilings and wall absorber systems, created two new acoustic ceiling solutions for cleanroom or healthcare environments. Hygiene Labotec Ds C1 and Hygiene Labotec Air A C1 offer wall-to-wall sound absorption. Both are suitable for areas where there are demands on low particle emission and where occasional wet wiping and/or disinfection is required. While the Ds system has only vertical joints, which minimise dirt traps, Labotec Air ensures optimised air permeability and limits air leakage through the ceiling.

Hygienic floors

Polysto Flooring supplies polymer composite kerbs and plinths that provide a solution to the hygiene challenges posed by kerbs made of concrete, which can be prone to damage and subsequent contamination. Made with polyester

The UK's Pirbright Institute for the study of animal diseases: pushing the boundaries of biological lab control



materials, they create a strong kerb that is easy to clean, is water- and chemical-resistant and repairable. The kerbs are bonded to the sandwich panel with a flexible, water-resistant polymer glue. The joints can be finished with a food-safe flexible sealant that is easy to dismantle for cleaning, or with a two-component polyurethane finish.

Other developments in floors included that of DekoFlake, based in Sunderland, UK, joining forces with Addmaster (UK) to develop antimicrobial hygienic flooring products incorporating Biomaster Protection to meet the requirement for extra levels of hygiene in critical care environments.

Biomaster Protection is a silver-based antimicrobial additive built into the DekoFlake products during manufacture, providing an antimicrobial effect that will not wash off. It has been proven to stop the growth of bacteria such as MRSA, E.coli, Listeria, Salmonella, Campylobacter, Legionella and Pseudomonas. Both the DekoFlake Biomaster Sealer and DekoFlake Hygiene System are suitable for high traffic areas such as hospitals, care homes, schools and in food processing environments.

Dycem launched a new contamination control floating floor system that offers facilities 99.9% decontamination on a range of subfloors. Developed for a variety of smooth, rough and uneven floor surfaces, the system is an alternative to Dycem's fixed and permanent systems, providing a solution for locations where long-term adhesion to the subfloor is not possible. Dycem polymeric flooring is installed onto a 1.2mm thick isolator membrane, providing a loose laid product option that can be self-installed in minutes, eliminating the need for any lengthy or disruptive installations.

The floating floor system is also suitable

for facilities where users wish to conduct Dycem trials or where a temporary contamination control solution is required. It is fully audit compliant, effective in removing 99.9% of foot and wheel contamination and up to 75% of airborne contamination, the firm says.

The system can be used at all entrances to critical areas to prevent the ingress of microbial contamination, all exits to reduce the risk of cross infection, inside critical areas to reduce airborne microbes and in corridors to prevent cross contamination and many other areas.

Doors and door furniture

Antimicrobial copper touch surfaces are seeing greater use in healthcare facilities around the world to augment existing hygiene procedures. The Copper Development Association reported on new research from the University of Southampton, which showed that the metal and many of its alloys will rapidly destroy norovirus, as well as other hospital acquired infectious agents. Door handles, taps, light switches, hand rails and more can be made from copper, or an antimicrobially-effective copper alloy, and will actively destroy pathogens, continuously reducing bioburden.

Ingersoll Rand, meanwhile, announced a range of door hardware products made with CuVerro bactericidal copper alloys during the 2013 American Society for Healthcare Engineering (ASHE) Conference and Exposition in Atlanta.

Assa Abloy Security Doors supplied and installed products for a £54m new Life Sciences Building at the University of Bristol.

The building includes teaching and research labs, as well as offices and lecture theatres. The company scheduled Powershield steel doors and ironmongery throughout the 13,500m² flagship project.

When working with substances that are hazardous to human health, one of the first lines of protection is to confine the material to a space where it can be contained or isolated from those who have to handle it. This area can be as small as a benchtop glovebox or as big as a room and may involve several technologies to achieve the goal of containment.

As Active Pharmaceutical Ingredients (APIs) become increasingly potent, in particular cancer treatments, the measures to eliminate the risk of accidental exposure become increasingly important.

Powder Systems (PSL) has refined a range of contained vessel charging solutions that will protect both operator and product down to nanograms containment levels. The glovebox isolators are suitable for charging slurry and powder into reactors and other vessels from small-scale synthesis to bulk production.

The company has also enhanced its SlurryBox to enable charging of highly potent slurry into reactors through pressured vessels. The powder is charged safely into the vessel from the SlurryBox, then liquid is brought in through nozzles to create the slurry. This method presents less risk of contamination with highly potent powder as the product is moved within the site in a liquid state. Finally, the slurry is directly transferred from the vessel into the reactor under pressure for a better flow control.

Kitting out potent facilities

PSL was one of the suppliers involved when Swiss company Helsinn Advanced Synthesis (HAS) opened a new cytotoxic facility dedicated to the development, analysis and manufacturing of clinical and commercial cytotoxic APIs. The facility has a 3b category with an Occupational Exposure Level (OEL) of less than 50ng/m³ for the protection of the operator, environment and product when handling cytotoxic compounds.

PSL worked closely with HAS to develop suitable solutions for the cytotoxics plant and supplied a suite of high containment systems, including contained Hastelloy pressure filter dryers, charging glove boxes with slurry vessels and complete clinical trial production facilities. The resulting state-of-the-art cytotoxic plant showcases the latest technologies available on the market for advanced production of highly potent compounds and is an example of successful project implementation and management from both Helsinn and its suppliers.



CREATIVE CONTAINMENT FOR POTENT PROTECTION

As pharmaceuticals become increasingly potent, the systems to protect those working with toxic substances have had to become more effective and more flexible. Hilary Ayshford summarises some of the recent developments

GEA Pharma Systems partnered with Penn Pharma in providing containment systems for the latter's £14m purpose-built facility for the development and manufacture of high-quality oncology drugs in Tredegar, Wales. The two companies worked together from the outset to develop an initial concept and select the technologies required, then co-operated with the engineering consultants to ensure that the plant was optimally designed for containment using a design-for-manufacture approach. GEA used its

containment expertise to eliminate the use of isolation suits in favour of containment interfaces. Penn Pharma now operates a high-containment cGMP manufacturing plant for the production of APIs in batches of 1–120kg. Highly contained equipment trains were designed to minimise the need for personal protective equipment (PPE) and reduce the use of isolators to a minimum.

Another pharmaceutical manufacturer looking for a containment solution was Piramal's Pharma Development facility in

