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IT Systems Cabling in Buildings: Environmental Issues

Modern commercial buildings contain large amounts of cable and wiring used for electrical power distribution, building control, and information technology (IT) systems. The amount of IT cabling in buildings has increased exponentially since the near universal adoption of desktop PC's and the "Client/server computing" model. In 1991 there were approximately 5 billion feet of plenum cable in place. In 1997 the estimated length was 30 billion feet of plenum cable and by 2000 the estimated growth showed the potential of 45 billion feet (Grenier, 2002) in 739,000 office buildings—60,000+ feet/building (DOE, 1999). This equates to approximately 1,323 feet of cable per office worker (U.S. Census, 2000).

Environmental Concerns

The main environmental concerns about IT cabling systems in buildings are:

- Material consumption, notably virgin-mined copper
- Production and use of PVC's for wire coatings
- Lead in wire coatings
- Indoor environmental hazards from lead dust
- Fire and smoke hazards in buildings
- Disposal of old cable

IT cabling – The Basics

IT cables consist of a metal or fiber optic (glass) core wrapped in a plastic sheath. Most buildings today install a "structured" cabling system that is designed to meet voluntary, but well established, performance standards. Those systems are usually separated into voice and data sub-systems. Voice systems typically use twisted-pair copper cables for both vertical (riser) and horizontal cables. Data systems commonly use fiber optics for risers and copper for connecting PC's to data network hubs. Frequently cabling systems also include separate "co-axial" cables for video systems.

The most common system for routing cables in commercial buildings is placing riser cable in sealed conduits that are firestopped according to fire code requirements. Horizontal cables are usually routed through ceiling, wall and raised floor areas, generally with metal conduits used only as protective guides behind sheetrock walls. The routing of cables through ceiling air plenums requires the use of specific "plenum-rated" cables with outer coatings that meet specific fire code requirements for flammability.

Material Consumption

Virgin materials are almost always used in manufacturing IT cables because IT cables are not easily recycled, and because recovered copper and glass is generally not pure enough to reliably transmit electric current or data. Fiber optics are manufactured in a highly controlled industrial process called modified chemical vapor deposition (MCVD) that appears to have relatively low environmental impacts, and little is known yet about recycling of fiber optics due to the youth of the technology and its extraordinary capacity compared to copper.

The consumption of copper, however, is a major concern. Every year 1.5 billion pounds of copper is freshly mined for use in IT cables. The extraction, refining and processing of these raw materials is energy intensive and leads to emissions and environmental degradation (Wilson, 2004). In copper mining, as much as 80% of the original rock moved becomes waste that contains high concentrations of toxic materials. Mining has serious local and regional impacts on water quantity and quality, air and soils, and on the social and cultural environments where it takes place (Moran, 2000). In 2002, U.S. copper and copper alloy consumption in electrical and electronic applications reached approximately 17 billion pounds (Copper.org, 2005) and produced roughly 85 billion pounds of waste.

In addition, copper production is incredibly energy intensive, requiring approximately 130 gigajoules of energy/ton for mining, smelting and processing (Surges, 2002, United Nations, 1992)--the energy equivalent of burning 13,000 pounds of coal (Energy.gov, 2004). Additional energy and materials are required for the packaging, transport and distribution of copper.

Production and use of PVC's for wire coatings

Today, most IT cable cores of copper or glass are "clad" or "jacketed" in polyvinyl chloride (PVC), a petroleum-derived plastic. In 1999, wire and cabling insulation and jacketing manufacturing accounted for 592 million pounds of PVC use in the United States (Greiner 2002, 1).

PVC production, use and disposal result in the creation and release of large amounts of toxic chemicals, hazardous gases, endocrine disrupting chemicals and organochlorines. Many organochlorines have established links to cancer, birth defects, immune system suppression, diabetes, impaired neurological development, and reproductive disorders in both humans and animals (Belliveau and Lester, 2004). Because of the persistent nature of the chemicals used to make PVC, any attempt to treat the waste products of production only creates other toxic by-products (Greiner 2002.)

According to the US Environmental Protection Agency, PVC production, use and incineration is the largest single source of dioxins, a group of powerful carcinogenic endocrine disrupters (*ibid*). PVC manufacturing also releases chlorine and vinyl chloride monomer gases—these are highly toxic and explosive greenhouse gases that pose hazards to workers and fire crews while driving global warming and climate change (*ibid*).

Lead in cable coatings

While the toxicity of pure PVC production, use, and disposal alone is ample cause for concern, IT cable manufacturing requires further additives for plasticity, heat and fire resistance, and color. The most significant of these additives is lead, which is added to PVC as a heat stabilizer and plasticizer. Like the constituents of PVC, lead is a persistent, bioaccumulative, toxic chemical (*ibid*). It can cause severe developmental disorders at even low exposures, and is associated with brain and kidney damage, blood and central nervous system disorders, and gastrointestinal distress. The US EPA limits lead exposure to 220 parts per million.

In the typical IT cable manufactured today, lead generally makes up 2-8% of the jacket, or 30,000 to 40,000 parts per million—136 to 181 times the EPA limit (Lobash, 2003). At a weight of 29 pounds/1000 feet for a typical Belden (2005) networking cable (4 Pair UTP, 200MHz Category 5e), that puts 35-139 pounds of lead in a typical U.S. office building, and 26.1 to 104.4 million pounds of lead in all U.S. buildings. As cable ages and the jacket become brittle, the lead migrates to the surface, producing a dust with a high lead content. "This dust, loose in ceiling or floor plenums, can easily reach building occupants or workers removing old cable." (Wilson, 2004)

In California, a state law created in 1986 by popular vote as "Proposition 65" requires the State to publish and annually a list of chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm and to required labeling of products that include these substances. The amount of lead found in even small electrical cables such as Christmas tree lights requires those products to be labeled as potentially hazardous. However, IT cables are expressly exempted from that requirement due to a legal settlement negotiated by the National Electrical Manufacturer's Association (NEMA) The basis for the exclusion is that IT cables are "infrequently handled". (NEMA 2002)

Indoor environmental hazards from lead dust

As noted above, recent studies show that as the PVC covering on cables deteriorates with heat and time, particles of lead and other additives migrate to the surface and accumulate as hazardous dust behind walls, beneath floors, and above ceilings, where they can readily circulate through building ventilation systems. Also, workers who install, remove or otherwise handle the cables on a regular basis are also exposed as chaffing even new plenum cable jackets against hands, cable trays or other structural elements can cause lead to be released (Greiner, 2002, Wilson, 2004).

Though the potential hazards due to lead dust from data IT cables are not generally known, building owners are evaluating the potential for legal liability. In 2003 the International Building Owners and Managers Associations (BOMA) met to discuss the new NEC 2002 code requirements for the removal of abandoned cabling in commercial buildings and the impacts of the code on building management and lease negotiation (Fishman, 2003). Others have speculated that lead dust from IT cables has the potential to be a legal issue on the scale of asbestos (Matney, 2004).

Fire and smoke hazards

The amount of IT cabling in commercial buildings—much of it installed in plenum spaces) presents a substantial fire hazard. "Because of the high volume of air flow in these horizontal open spaces, fires can spread with alarming speed and introduce copious amounts of smoke and gases or fumes into the ventilation system." (Peri, 2000). Peri also note that for "every 1,000 feet of 4-pair UTP (unshielded twisted pair) LAN plenum cable installed puts approximately 11 pounds of plastic material for insulation and jacketing in the plenum area." This creates a substantial fuel load that can act as a "highway" for fire and produce toxic gases from burning—or even overheated—cable (Bisbee, 2005).

The NEC 2002 Article 800, Section 800.2 discussed above, requires removal of abandoned cables—those unused and not marked for future use—in ceiling and floor plenum spaces. Removal is generally required during building renovations or remodels, before new cable is installed. The NEC change was motivated by the potential fuel load, while doing nothing to address the hazards inherent in the material itself, or the dangers of its removal. For future, NEC may require use of CMP-50, a new limited combustible cable which should sharply reduce chemical exposure during fires and reduce fuel load (BICSI, 2004).

Disposal of old cable

Retired wire and cable are typically shipped to India or Pacific Rim countries where the cladding is stripped away and the copper recovered, but the difficulty of and lack of financial incentives for separating the chemicals that make up the jacket create a disposal problem (EBN, 2004). While there are claims that plastic wastes can be disposed of safely under controlled conditions (typically incineration), concerns remain about effluents and byproducts (BAN, 2000) and whether such wastes are being properly managed at their final destinations is questionable.

IT cabling codes in the U.S. and abroad

While US cabling code remains decidedly focused on fire resistance and smoke density of the cables, international standards are beginning to address the questions of toxicity. Tests have been convincing enough for many countries, including Australia, France, Italy, Japan, Korea, New Zealand, and the U.K. to limit, or even ban many of the components currently used in IT cabling.

The Waste Electrical, Electronic Equipment Directive (WEEE) takes effect across the European Union (EU) in 2006. Its objectives are the prevention of landfilling waste electrical and electronic equipment, promoting the reuse of electrical and electronic equipment, and improving "the environmental performance of all operators involved in life cycle of electrical and electronic equipment". (KTL, 2005). The associated Restriction of Hazardous Substances Directive (RoHS) bans use of some toxic materials such as lead, cadmium, and some brominated flame-retardants(Greiner 2002, p.4) which will require use of cable products that do not use such toxic materials.

Sources for additional information

Widespread Pollutants with Endocrine-disrupting Effects
http://www.ourstolenfuture.org/Basics/chemlist.htm

PVC, Bad News Come in Threes: The Poison Plastic, Health Hazards & the Looming Waste Crisis http://www.besafenet.com/PVC04/MajorFindings.htm

Will Cabling Fuel a Fire?: When it comes to fire safety, not all code-compliant cabling is created equal. www.facilitiesnet.com/BOM/Oct00/Oct00securitya.shtml

Economics_Of_Phasing_Out_PVC
www.healthybuilding.net/pvc/Economics_Of_Phasing_Out_PVC.pdf

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