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AT&T ENVIRONMENT AND SAFETY

"(A)s quality methodology teaches, acceptable performance is a moving target. On an issue as important and dynamic as the environment, our customers, our shareowners, environmental groups, the public and our own employees all expect AT&T to be a leader, to set the pace."

David R. Chittick, 1991
Vice President, Environment and
Safety Engineering

AT&T divested its local Bell telephone companies on January 1, 1984. The event focused the company on reshaping a new corporate identity and mission; environmental issues -- according to senior management -- "went underground" as more fundamental business imperatives took precedence.

In the ensuing years, environmental issues grew in importance to industry as legislation and public attention regarding the environment increased. With the passage of the Superfund Amendments and Reauthorization Act (SARA) in 1986, AT&T became more aware of its environmental liabilities.

AT&T

AT&T provides communications services and products to businesses, consumers, telecommunications service providers, and government agencies around the world. Its mission is to be the world's best at bringing people together -- giving them easy access to each other and to the information and services they want -- anytime, anywhere. In 1991, the company's worldwide network carried more than 125 million voice, data, video and facsimile messages every business day. On the busiest calling day of the year, the Monday after Thanksgiving in the U.S., AT&T handled nearly 158 million calls, and all but 211 of them went through on the first try.

AT&T and Environmental Regulation

In 1984, a toxic cloud was released from a Union Carbide chemical plant in Bhopal, India, killing almost 3,000 people and injuring some 25,000 more. As a result of this incident, Congress enacted Title III of SARA in an attempt to ensure the American public that a Bhopal incident could never happen in the U.S. The main thrust of SARA was to make parties responsible for contaminated sites responsible for cleanup. Title III of the legislation required companies to report to the government the amount of toxic chemicals kept in inventory each year and the amount they released or emitted to the environment. "The mere public disclosure of emissions, as required by SARA Title III, was enough to stimulate a major shift in company policies, attitudes and action."[1] Public disclosure of emissions data also provided new ammunition for community action groups and the media.

With the introduction of the Toxic Release Inventory (TRI), companies could track -- many for the first time -- where in the production process toxic chemicals were being used, and points of vulnerability where the chemicals were released into the environment by way of air, water or land media. "As AT&T gathered data on emissions in compliance with SARA Title III, the company was able to see how many pounds of materials were going out its smokestacks. The company wanted those numbers reduced dramatically."[2]

The economics of waste production also emerged as an issue in many businesses. Companies began to view pollution as a sign of inefficiency within their manufacturing processes, and waste as a nonrecoverable cost. As regulations proliferated, waste treatment and disposal fees increased, and, as competitive conditions tightened, companies were driven to incorporate pollution prevention into their operations management as a means of cutting costs.

As AT&T stated in its 1992 Environment and Safety report:

> The burden of environmental regulation on our business is substantial. In the U.S. alone, federal and state governments have enacted more than 80,000 environmental regulations since 1981. Simply tracking and reading these regulations -- not to speak of interpreting and applying them to company operations -- is a staggering load.[3]

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1. Bruce Smart, Beyond Compliance - A New Industry View of the Environment, Washington, DC: World Resources Institute (1992).
2. David R. Chittick, Organizing an Environmental and Safety Protection Program for Maximum Effectiveness, Morristown, NJ: AT&T (1992).
3. "A Healthy Balance," AT&T Environment and Safety Report, 1992.

A number of companies integrated pollution prevention programs into existing total quality management (TQM) programs. TQM stresses the notion of "continuous improvement" of product quality, and emphasizes "zero defects" and "customer focus" as the two objectives for manufacturing organizations. Minimizing pollution is consistent with these overall objectives; pollution was seen as a defect in the process, while good environmental performance is similarly valuable to all company customers, including employees and local communities.

As a result, pollution prevention emerged as a quality issue in many industries. Instead of controlling pollution with "end-of-pipe" solutions such as "scrubbers," plant managers attempted to eliminate waste by examining the entire process -- from materials input to end-of-pipe emissions.

Ozone Depleting Substances

Companies like AT&T also were increasingly affected by international environmental agreements. In September 1987, the Montreal Protocol on Substances That Deplete the Ozone Layer was formulated by 60 countries to reduce the production, consumption, and general use of industrial compounds called chlorofluorocarbons (CFCs), to avoid depletion of the stratospheric ozone layer. Beginning in the early 1970s, scientists theorized that CFCs were depleting ozone concentrations in the stratosphere (10-50 km above the earth's surface) which shields the earth's surface from potentially disastrous levels of ultraviolet radiation (UV-B). Specific effects of UV-B were poorly understood, yet scientists generally agreed that an increase could threaten human life, harm forests, fisheries, and agriculture, and advance global climate change. At the time of the negotiations, CFC use was increasing rapidly in volume and variety of use, and new compounds were proliferating. CFCs were considered to be relatively benign: inert, non-toxic, and non-flammable. They also were abundant, useful and cheap. CFCs were present in thousands of products, including aerosol sprays, industrial solvents, air conditioning and refrigerator equipment, and foam insulation.

The Montreal Protocol formally took effect on January 1, 1989, with the 29 signatory countries and the European Community accounting for 83% of global consumption. However, new scientific findings indicated that the provisions of the protocol were not strong enough. The London Revisions to the Montreal Protocol of June 1990 significantly quickened the pace of the reductions and provided for total elimination of CFCs and other ozone depleting substances (ODS) by the year 2000.

Montreal Protocol Reduction Schedule

CFCs	50% reduction in 1995 80% reduction in 1997 Phaseout 2000
Methyl Chloroform (1,1,1 Trichloroethane)	Freeze 1989 levels in 1993 30% reduction in 1995 70% reduction in 2000

	Phaseout 2005
Halons	50% reduction in 1995 Phaseout 2000
Carbon Tetrachloride	Freeze 1989 levels 85% reduction in 1995 Phaseout 2000
(Note: reductions based on 1986 levels)	

Source: United Nations Environment Programme

Many national governments propagated phaseout schedules with even tighter deadlines. Former President George Bush announced that the United States would halt all CFC and ODS production by December 1995. This presented a daunting challenge to industrial users of these substances. Virtually the entire telecommunications industry, including AT&T, used CFCs and other ozone depleting substances throughout their manufacturing processes.

Legislation under the Clean Air Act of 1990 further restricted CFC use by mandating that all products that contained any ODS carry a warning label. By the end of 1992, the EPA had not specified whether all suppliers in the life-cycle of a product needed to label their components with an ODS warning tag. Labelling legislation presented further incentives for companies to eliminate all CFC and ODS use.

AT&T Environment and Safety Management

Shortly after SARA Title III was enacted in 1986, David Chittick took over the Environment and Safety (E&S) function; remaining E&S organizations throughout the company were merged two years later. The new group undertook the task of developing goals, objectives, and strategic plans to help AT&T attain the highest standards of environmental and safety performance. Chittick's vision was to make AT&T a leader in environment and safety -- just as the company was a leader in the telecommunications business -- and he worked with other senior managers to establish objectives that would go further and faster than laws, regulations, or international guidelines required. AT&T's policy also was designed to guide the company towards preventing pollution at the source, rather than depending on abatement, which tends to be more costly. While abatement could minimize polluting emissions with scrubbers or other devices, Chittick did not believe this was a long-term solution.

E&S Objectives

At the 1990 shareholders' meeting, Chairman Bob Allen publicly committed the company to five environmental and six safety goals, which would apply to some 40 major manufacturing locations and 2,500 non-manufacturing locations worldwide. Using 1986 as the base year, the objectives marked a clear course for the company.

AT&T Environmental Goals

Chlorofluorocarbon (CFC) Phaseout
- 50% by 1991
- 100% by 1994

Total Toxic Air Emissions Elimination
- 50% by 1991
- 95% by 1995
- Strive for 100% by 2000

Decrease Total Manufacturing Process Waste Disposal
- 25% by 1994

Increase Paper Recycling
Increase recycling of paper to 35% by 1994
Decrease paper use 15% by 1994

Promote Safety
Greater involvement in the OSHA Program

Source: AT&T, *A Clean and Healthy Planet: AT&T Environment and Safety Report on Activities*, Morristown, NJ (1990).

AT&T adopted three fundamental approaches towards achieving its E&S goals:

First, we're applying quality principles to all operations. We want to handle materials more efficiently and to minimize waste in all operations. Every toxic emission, every pollutant, every pound of solid waste is a cost of non-conformance in a quality sense: a defect our quality processes shouldn't tolerate. Second, we're applying technology to environmental problems. We're using new manufacturing technologies and exploring new applications of information technology. Third, we're accelerating existing programs, such as recycling, and innovative packaging for our products.[4]

By the end of 1991, the company had made substantial progress towards the environmental goals and had received numerous awards for its achievements. (See **Exhibit 1**.)

AT&T Partnerships

AT&T joined with Northern Telecom and the U.S. EPA to found ICOLP, the Industry Cooperative for Ozone Layer Protection.[5] This consortium was designed to stimulate the exchange of non-proprietary technologies that eliminate ODS use. AT&T also became a member of the United Nations Environment Programme, a 12-member committee of experts that addressed CFC alternatives in developing and industrialized nations. The research and technology transfer spawned by the company's involvement in ICOLP and other outreach activities created an incentive for AT&T to form other partnerships to share information on environmental protection programs.

One such partnership was the Global Environmental Management Initiative (GEMI), an industry consortium of E&S professionals formed to foster environmental excellence by business worldwide.

4. AT&T Environment & Safety Engineering, Goals and Progress, Morristown, NJ: AT&T (1991).
5. For more information, see "Industry Cooperative for Ozone Layer Protection" in Frederick J. Long and Matthew B. Arnold, The Power of Environmental Partnerships, Fort Worth, TX: Dryden Press, (1995).

Tom Davis, AT&T's E&S Affairs Director, chaired the Quality Management Committee for GEMI, sharing total quality programs used effectively at AT&T for pollution prevention with other members. Another program founded by AT&T was the Environmental Management Roundtable, a group of industry executives who met to discuss and share common environmental and safety problems.

In 1992, AT&T became a member of the Quality Environment Management (QEM) Task Force of the President's Commission on Environmental Quality (PCEQ). PCEQ was formed in July 1991 by President Bush, and was comprised of 25 environmental, business, academic, and foundation leaders. Tom Davis, who represented the company on the Task Force, was asked to adopt a project at an AT&T facility that would demonstrate how TQM principles could be applied to pollution prevention programs in a manufacturing facility. Representatives from the EPA and an environmental group also were asked to be part of the project, to show that environmental improvements can be achieved through teamwork between industry, the community, and regulators, thus providing an economically viable alternative to government regulation. The project would give AT&T the opportunity to test whether partnerships between the company and other organizations could be as productive and successful at the facility level as they had been at the corporate level.

The Columbus Works Facility

In October 1992, AT&T's Columbus Works celebrated its 35th anniversary. The facility, which manufactured telecommunications equipment and housed a division of Bell Laboratories, was one of the oldest AT&T plants still in operation. The 1.5 million square foot facility was located in the suburbs of Columbus, Ohio and employed approximately 6,000 people.

Over 100,000 customized products were manufactured at the Columbus Works. Although a few products were sold directly to outside clients, most of the customers served by the facility were other AT&T companies. For example, long-distance switching systems built at Columbus were sold to the AT&T long-distance operating division. Other electronic equipment served as a component of larger systems that were assembled at other facilities. Columbus Works provided equipment for three AT&T business units which marketed the following products:

- **Wireless Communications Systems** -- *Autoplax System 1000 Series* was a base station for digital radio units that supported mobile telephone systems.
- **Switching Systems** -- *4ESS Switch* was a long distance switching unit that redirected long-distance phone calls at regional sites.
- **Network Systems** -- *Data Kit II Virtual Circuit Switch* allowed communication between different types of computers. *BNS 2000* enabled telephone companies to offer their customers a comprehensive set of data and high-speed networking services.

E&S Structure and Quality Architecture

The E&S organization at Columbus Works was headed by Al Rauck and consisted of the following employees and assignments: Gordon Bersebach, Industrial Hygiene; Jerald Garrett, Safety Engineering; Dale Howell, Environmental Engineering; Gary Liebschner, Emergency Planning; Neil Marquard, Industrial Hygiene; Barbara Thompson, Environmental Engineering; and Fred Wiles, Fire Protection. (See **Exhibit 2**.)

Columbus Works monitored approximately 20,000 chemicals that were or had been in use at the facility. Before a new chemical could be introduced into the manufacturing process at Columbus, it was required to pass through a verification procedure. First, it had to comply with AT&T and Bell Laboratories product standards; next it was passed to Gordon Bersebach or Neil Marquard to verify that its intended use met AT&T safety standards (which were often more stringent than federal regulations); then it was referred to Barbara Thompson to determine whether the chemical had to be monitored and documented under SARA Title III, or if the new process using the chemical created air emissions that required a new permit; finally, Dale Howell determined how the chemical must be disposed of in compliance with federal and state regulations. In general, "Ohio has nothing above federal requirements for pollution," according to Mike Kelly, of the Ohio EPA, so that if the Columbus Works engineers met federal standards, they met local and state regulations as well.

Along with the formal reporting structure maintained at the facility, Columbus had an informal *quality architecture* established in 1987. (See **Exhibit 3**.) The architecture grew out of an increasing focus by AT&T on the use of total quality management concepts. In 1982, Columbus instituted quality circle teams as a means of empowering factory workers to resolve manufacturing process inefficiencies and prevent sub-standard production. These teams evolved into what came to be known as *cell teams*, which included supervisors and process engineers who generally met twice a month. For support organizations such as E&S, *process management teams* were formed. If a problem was encountered which could not be resolved by the cell or process management team alone, it was referred up the chain to a line or process team, and later to the plant or executive teams if the scope was plant-wide.

Environmental and safety quality were part of the company's overall quality program. AT&T emphasized six principles of TQM:

1. The customer comes first.
2. Quality happens through people.
3. Prevention through planning.
4. All work is part of a process.
5. Quality improvement never ends.
6. Suppliers are an integral part of business.

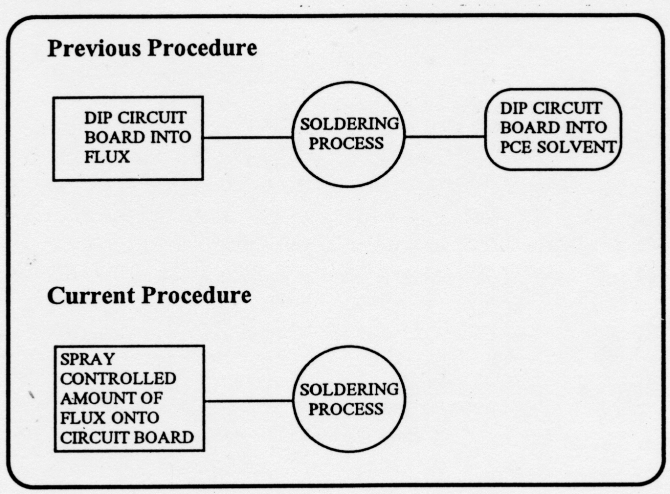
Pollution Prevention

In 1988, *The Columbus Dispatch* depicted AT&T as the second largest air polluter in Ohio. (See **Exhibit 4**.) The company, along with many other companies in the electronics industry, was a large user of perchloroethylene (PCE), which was used to remove flux after soldering. (See **Exhibit 5**.)

AT&T felt that the graph was misleading, because the 1987 data represented single chemical emissions rather than the total toxic air emissions of a facility. Still, this negative publicity spurred the Columbus Works facility to adopt an aggressive pollution prevention program. According to Girish Parikh, Senior Engineer at Columbus Works, "We had to get rid of it."

The first group at the plant to utilize the quality process for pollution prevention was the soldering cell team, the quality team overseeing the assembly of circuit-pack boards for switching systems. The team used PCE to clean circuit-pack boards after soldering. Parikh and Gerry Renner, the process engineers who oversaw the circuit-pack assembly process, contacted Bell Laboratories in New Jersey to learn of any research regarding PCE substitutes. However, rather than investigating other cleaning agents, Bell Laboratories found that a low-solids flux, when applied in even and controlled amounts, would not leave the tacky residue that required cleaning. Rather than substituting another solvent for PCE, the engineers redesigned the soldering process so that cleaning was no longer required.

To use the new fluxing procedure, process engineers needed to design a new machine that would spray flux on the circuit boards during the production process. Within one year, new equipment was installed in the soldering cell team's area that sprayed a controllable amount of the low-solids flux on the circuit-packs before sending them through for soldering. The tanks of PCE were removed from the area entirely, eliminating a bothersome odor for plant workers. The new process reduced materials costs substantially and opened up factory floor space for other purposes. The new equipment had a payback period of less than twelve months.



Source: AT&T

PCE also was used in the soldering of wire to small connector units, producing a smooth, finished product. Engineers did not find an adequate substitute to perform the operation. Instead, they decided that because customers rarely saw the solder, and because a smooth solder joint was not critical to the operation of the connector, the final product could be left rough. The facility eliminated the 35,000 gallons of PCE it purchased each year, dramatically reducing its toxic air emissions. This action also eliminated the need for related industrial hygiene and environmental monitoring activities, and generated cost savings of $210,000.

In 1990, when AT&T established its environmental goals, Columbus Works was already in good standing to meet the target dates. The facility was scheduled to become CFC-free by the end of 1992, two years ahead of corporate's goal of 1994. In addition to PCE, ammonia was also eliminated from use at the facility. These actions generated an 84% reduction in toxic air emissions from 1987 to 1992, compared to company-wide reductions of 73%.

The PCEQ Project

In early 1992, David Chittick paid a visit to the Columbus Works facility, and was impressed by a presentation made by the E&S department depicting the facility's advancement toward AT&T's corporate environment and safety goals. Intrigued by the commitment made by plant manager Bill Robinson to environmental issues and to the extensive use of TQM tools to address the plant's environmental problems, Chittick recommended the facility be chosen as the company's PCEQ site. The project, overseen by the Quality Environment Management Task Force of PCEQ, aimed to develop and implement a program demonstrating that environmental improvements through pollution prevention can be achieved by applying Total Quality Management principles.

Because Columbus Works would be CFC-free in 1992, the first E&S objective -- phasing out CFC emissions from manufacturing operations -- already had been successfully addressed. The second corporate goal -- eliminating all toxic air emissions -- had not yet been fully achieved. Rauck put Barbara Thompson, the environmental engineer responsible for SARA Title III, maintaining TRI data, and complying with the Clean Air Act, in charge of the project. Her first task was to further investigate how Columbus Works could apply TQM principles to eliminate total toxic air emissions from the plant.

Thompson began by charting all toxic air emissions, using the 1991 TRI data that she already had collected. (See **Exhibit 6**.) CFC-113 already would be eliminated by end of year 1992. The next largest chemical emitted from the plant in 1991 was trichloroethylene (TCE). TCE was used at Columbus in a manufacturing unit that was scheduled to be eliminated by the end of 1993. Thompson analyzed the alternatives available to reduce the use of TCE, and given the capital constraints, found that sticking with the current phaseout schedule was the most cost-effective option.

Turning next to 1,1,1 trichloroethane (TCA), Thompson found an opportunity. (See **Exhibit 7**.) The E&S department had not yet targeted TCA for reduction. This chemical solvent was an ODS included as an addendum to the Montreal Protocol. TCA also was the most commonly used cleaning solvent reported under TRI in Ohio.[6] Again using the 1991 TRI data, Thompson identified

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6. Kurt Kohler and Anthony Sasson, "Multi-Industry Success Stories to Reduce TCA Use in Ohio," Pollution Prevention Review, Autumn (1993).

which business units were the heaviest emitters of TCA. (See **Exhibit 8**.) Not only could Thompson analyze the emissions by business unit, she also could determine the usage and emissions data by shop. Each shop represented a process within the business unit, and the engineer assigned to that shop compiled the usage and emissions data that eventually were incorporated into TRI. Thompson created the following table which highlighted the shops that accounted for 78% of total 1991 TCA emissions and 84% of 1991 TCA usage:

Table 1

Business Unit	Shop	TCA Usage (lbs)	TCA Emissions (lbs)	Engineer
50-Switching	Assembly	2446	1991	Terry Keating
50-Switching	Circuit-pack Repairs	2440	1279	Ron Mack
50-Switching	Circuit-pack Assembly	960	960	Girish Parikh
10-Maintenance	Tool Room/Machine Maintenance	4750	650	Jim Caudill
50-Switching	Miniature Wire-Spring Relay	686	686	Jim Buckenberger
50-Switching	Circuit-pack & Wiring Equipment Testing	280	280	Gary Sheeler

Thompson immediately focused on the shops that were heavy emitters of TCA, and selected the engineers of those shops to be part of the Process Management Team established to address TCA reductions. Thompson called the first meeting of the Process Management Team and asked Gerald Comisford, Senior Quality Specialist in Quality Management, and Neil Marquard, Engineer in Industrial Hygiene, to join the team as well. The reduction objectives of the team were: 50% reduction in use and emissions of TCA by year-end 1991 and 100% elimination of TCA use and emissions by year-end 1995.

The reductions would be measured using the monthly TRI data collected by Thompson. The team used a ranking system to choose among TCA reduction or elimination alternatives:

1. Eliminate the manufacturing process that uses TCA
example: if TCA is involved in a cleansing process that is used to make the product attractive, but not more efficient, possibly the cleansing process can be eliminated.

2. Substitute TCA with a non-toxic chemical
example: if TCA is used in combination with another chemical to achieve a certain reaction, possibly a non-toxic substitute exists that achieves the same results but does not require SARA III reporting and does not contain CFCs.

3. Substitute TCA with a less toxic chemical or reduce the use of TCA
example: same as above

4. Install emission control equipment
example: create a ventilation system that pulls TCA vapors away from employees and traps TCA in a storage tank, so that it can be removed as hazardous waste.

The aids and barriers for TCA elimination at Columbus Works also were defined.

Aids:

- Improved environment -- inside and outside of plant
- Potential cost savings -- materials, facilities, raw materials and waste management
- Reduced regulatory requirements and reports -- SARA, OSHA, etc.
- Improved public image
- ODS labeling requirements -- effective 5/15/93
- ODS phaseout 12/95

Barriers:

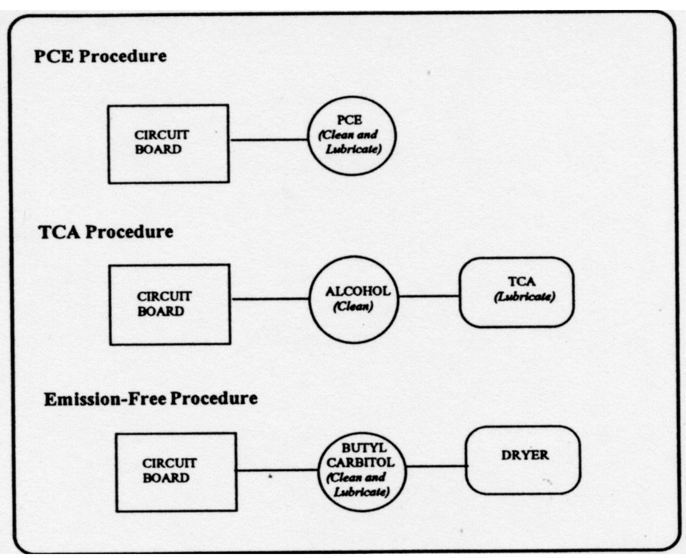
- Finances were tight, could not allocate funds at the time
- Did not have resources to devote to this project
- Down time in shop to implement changes
- Designer and customer approval possibly required
- Alternatives might pose different environmental or safety problems (i.e. permitting)
- Product line had short life.

Once the Process Management Team defined the goals, incentives, barriers, and metrics for the project, team members brainstormed approached to TCA reductions in their own process area. To eliminate TCA, Thompson believed that "you must track it by process. If you don't, you won't be able to follow where it's used." The process engineers shared information on substitute chemicals and manufacturing process design modifications that had been used effectively in other pollution prevention projects. The team met in May 1992 and again in June before the process engineers presented their preliminary reduction plans in July 1992. From then on, the team met as needed, but implementation of the plans was expected to take place immediately.

Circuit-Pack Assembly Continuous Improvement

Through the task force, Thompson became aware of the wide variety of uses for TCA in the shops. (See **Exhibit 9**). Parikh, one of the larger users of the product, recently had introduced TCA to his shop as a process change made to eliminate PCE. The end of a switching unit circuit board was lined with a series of "gold fingers" -- thin finger-like extensions made of gold and designed to link with other components in the switching unit. Previously, these gold fingers were dipped into PCE to ensure that they were clean and lubricated, and, because PCE dried very rapidly, capped immediately with a plastic cover to avoid any dust settling. Parikh replaced PCE with a combination of alcohol (for cleaning) and TCA (for lubricating), using both under an evaporative vent that pulled toxic air emissions away from the plant worker. Parikh contacted Bell Laboratories in Princeton for consultation. Bell Laboratories had been investigating alternative substitutes for ozone depleters such as TCA, and recommended that Parikh try the chemical butyl carbitol (BC).

Parikh found that BC was able to fulfill both the cleaning and lubrication functions, eliminating the need for TCA and the alcohol solvent; however, the chemical was slow to dry. He proceeded to order special drying equipment that would enable the machine operator to cap the gold fingers immediately. BC had some surprise advantages as well. The chemical had no exposure limits according to Occupational Safety and Health Administration (OSHA) standards, and did not pose the risk of flammability.[7] The chemical still had to be reported under SARA Title III, and Thompson wanted eventually to substitute a non-reportable item for BC. "The process is never complete," she maintained, "you just go on to the next step."



Source: AT&T

Switching Assembly Quality Management

TCA also was used in the switching assembly to clean ink stamps and ink rollers that placed a permanent numbering system on the circuit boards. To produce the 4ESS and 5ESS switching system units, a series of coded numbers was stamped by hand onto circuit board components to indicate wiring and component interface instructions. TCA was applied as a solvent to clean

7. Material Safety Data Sheet, NJ: Union Carbide Chemicals and Plastics Company Inc. (1992).

instruments used in the stamping process. A major source of emissions from this process was the cleaning station, where brushes and cloths were left overnight. For every gallon of TCA given out, only half was returned; the other half evaporated.

Introducing substitutes for TCA presented interesting consequences for Terry Keating, the process engineer responsible for switching assembly, where much of the stamping takes place. Plant workers liked TCA because it dried quickly, so that if they made a stamping error, it could quickly be wiped away and restamped. Because BC took longer to dry, plant workers had to use a dry cloth to wipe away the chemical before the piece could be restamped. Although the workers were interested in using a less toxic cleaning agent than TCA, they also wanted to maintain their productivity level. Keating managed to convince them that BC was the best alternative available.

Wire-Spring Relay Reductions

Before 1992, CFC-113 was used to clean and degrease the wire-spring relay apparatus used in switching systems. When Columbus Works began eliminating the use of CFCs in the manufacturing process, CFC-113 was replaced with TCA. In the effort to search for CFC and ODS substitutes, Bell Laboratories had been testing a variety of naturally occurring chemicals that would be potentially biodegradable. Earlier, Thompson and the process engineers tested such a flux chemical derived from orange peels, but found that the substance irritated workers' skin. Then Bell Laboratories discovered that the chemical n-butyl butyrate, which provided flavor to fruits such as cantaloupes, was an excellent solvent and could replace TCA in the manufacturing process.

Thompson received a phone call from an Ohio newspaper reporter requesting information about the "sweet" discovery, and how it might affect Columbus Works' operations, but she had no information yet about the possible TCA substitute. The n-butyl butyrate still was being tested at AT&T's North Andover facility, and information about the chemical had not yet been passed on to other AT&T manufacturing facilities. Expecting that the substance might be a perfect substitute for TCA use in the wire-spring relay production, Thompson began calling Bell Laboratories and the North Andover facility to learn more about the chemical. If the test results at North Andover were positive, Columbus Works planned to try the n-butyl butyrate in the wire-spring relay shop as a TCA substitute.

Working in Partnership with Outside Stakeholders

In line with the original PCEQ QEM Task Force objectives, two representatives from outside AT&T were asked to contribute to the PCEQ project. These were Mike Kelly, Manager of Pollution Prevention from the Ohio EPA and Ed Hopkins, Environmental Policy Director from the Ohio Citizen's Action Group (OCAG). PCEQ wanted to involve representatives from the government and community groups to add credibility to the project progress reports. Because the commission was made up of a partnership of stakeholders in the environmental protection process, an objective of the QEM project was to utilize all knowledge accessible to a company to reduce targeted emissions, including knowledge outside of the corporation.

Hopkins' organization, OCAG, was a grassroots community advocacy group which had, at one point, placed AT&T's name on a newspaper cartoon of a toxic waste barrel. The group was considered controversial by many industry members. Asking OCAG to join the project "demonstrated an openness by Al Rauck and Barbara Thompson," in Hopkins' view. Both Hopkins and Kelly met with Thompson to discuss the plans to reduce TCA emissions at the facility, and although neither offered substantial technical contributions, each believed that the PCEQ project at Columbus Works represented a single-medium rather than a multi-media program. Kelly warned that the project should "apply continuous improvement to pollution prevention," rather than "solve problems as they come up."

Project Results

The TCA elimination project did not produce any immediate savings in material costs. However, as an ODS regulated under the Montreal Protocol, TCA was expected to become more expensive as its availability was reduced. In 1989, one gallon of TCA cost approximately $5.80.[8] Furthermore, impending ODS labeling requirements were to become effective May 15, 1993. Process engineers at Columbus Works would be responsible for incorporating any new ODS labeling procedures into work stations that used TCA. AT&T estimated that for the company as a whole, the new tracking and labeling requirements could consume hundreds of thousands of dollars in administrative costs.[9]

Rauck and Thompson believed the project helped them identify the difficulties in implementing pollution prevention programs in manufacturing facilities, where numerous interests compete for engineers' and managers' time. They both believed that next steps for the facility beyond the project included:

Transfer of expenses for disposal of hazardous materials to product cost -- Environmental expenses were not charged to each business unit, but treated as an expense center for the facility. Until these costs were transferred to the business unit, managers would not have full motivation to minimize waste.
Integrate environmental issues into process design rather than at end-of-pipe -- Process engineers turned to the E&S department when they had a compliance problem. The solution in the past had been to install equipment to manage a waste stream rather than changing the process to eliminate the waste. Behavior needed to be modified so that the E&S group was seen as advisors to the design of the manufacturing process.
Promote partnerships -- AT&T wanted to be a permanent part of the community, and had to recognize, listen to and learn from the needs of outside stakeholders.

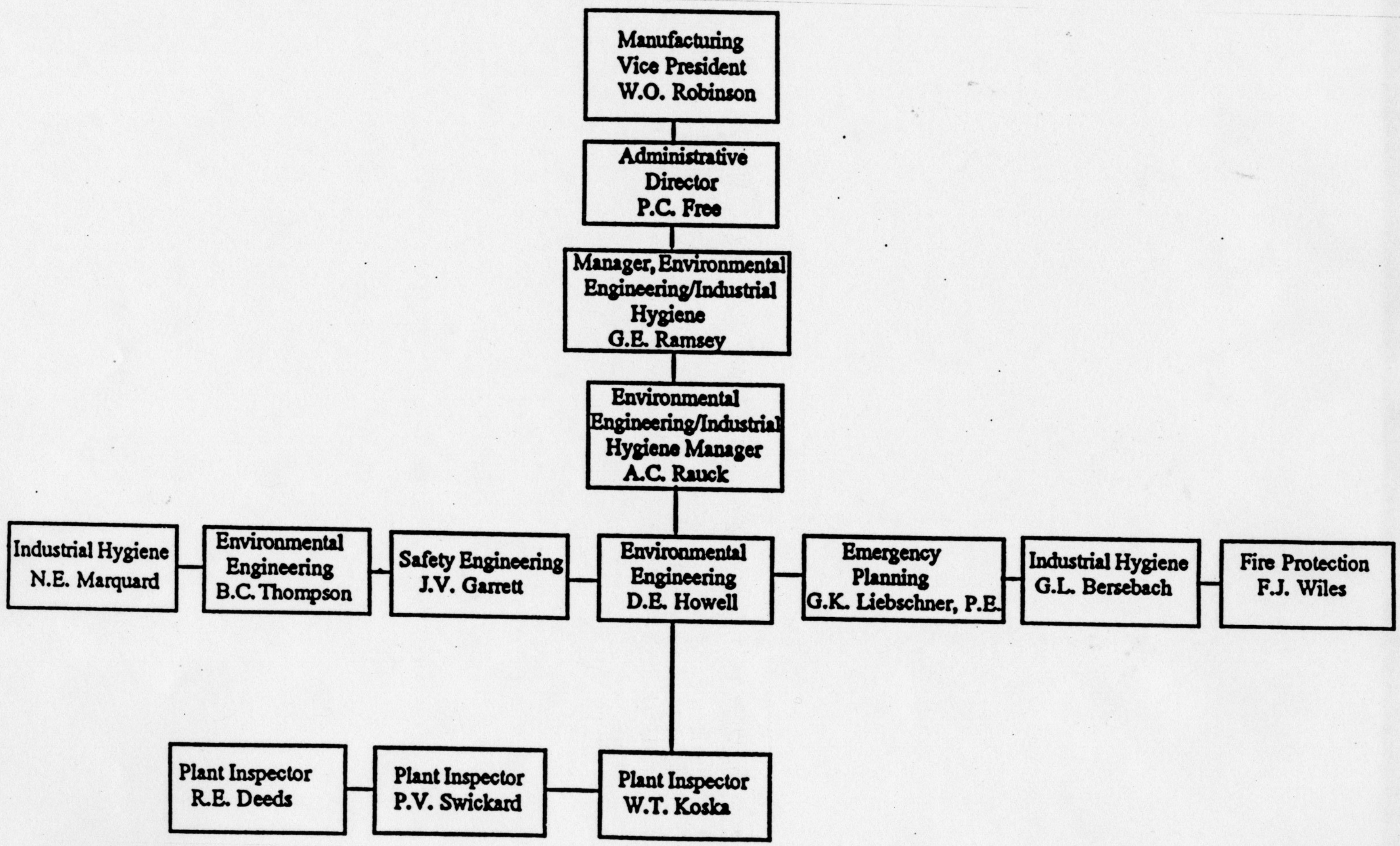
8. Kurt Kohler and Anthony Sasson, *op cit.*
9. "A Healthy Balance," AT&T Environment and Safety Report, 1992.

Exhibit 1: AT&T's Environmental Recognition

- 1990 Council on Economic Priorities Corporate Conscience Award for CFC reduction program
- 1991 New Jersey Governor's Award for Outstanding Achievement in Pollution Prevention for low solids fluxer work
- 1991 US EPA Administrator's Award (Region II) for corporate recycling program
- 1991 National Environmental Development Association Honor Roll Award for CFC reduction program
- 1991 National Association for Environmental Management Environmental Excellence Award for CFC reduction program
- 1991 President's Environment and Conservation Challenge Awards citation for CFC reduction program

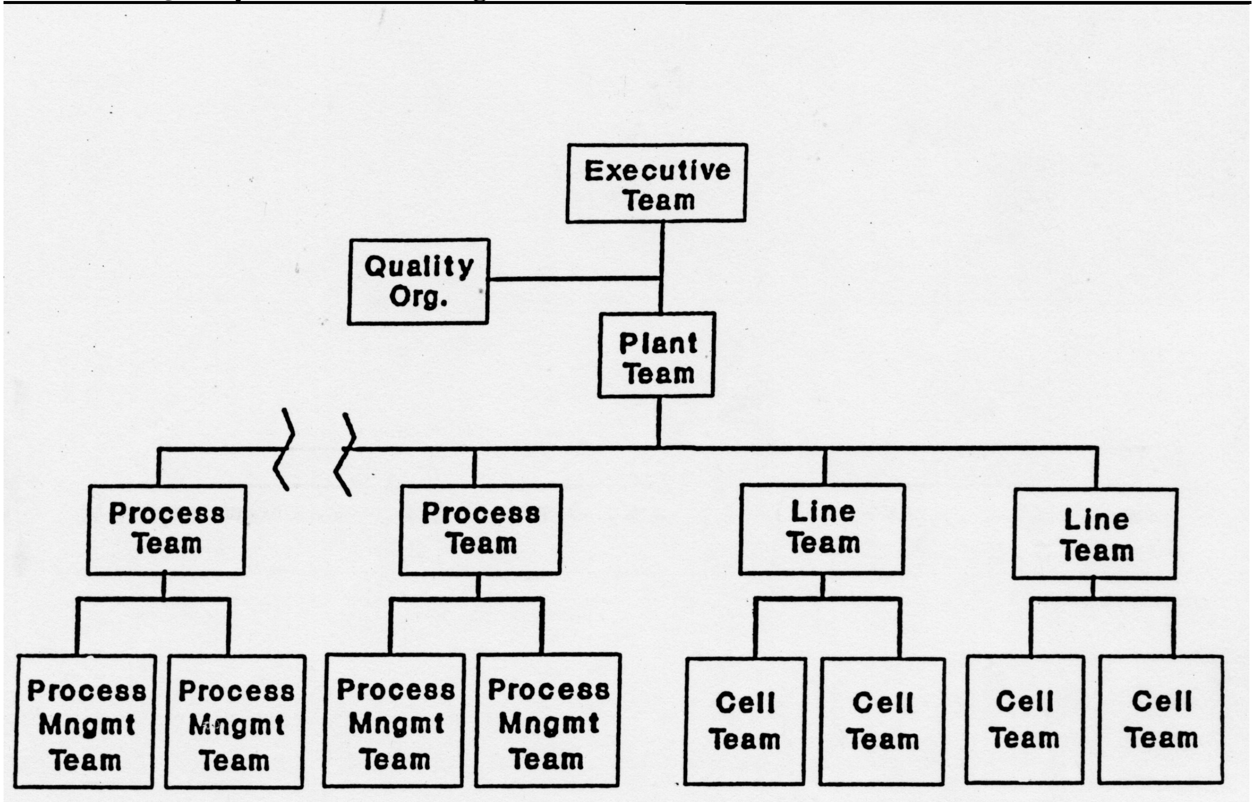
Source: Beyond Compliance: A New Industry View of the Environment, Washington, DC: World Resources Institute (1992).

Exhibit 2: Columbus Works: Environment and Safety Organization Chart



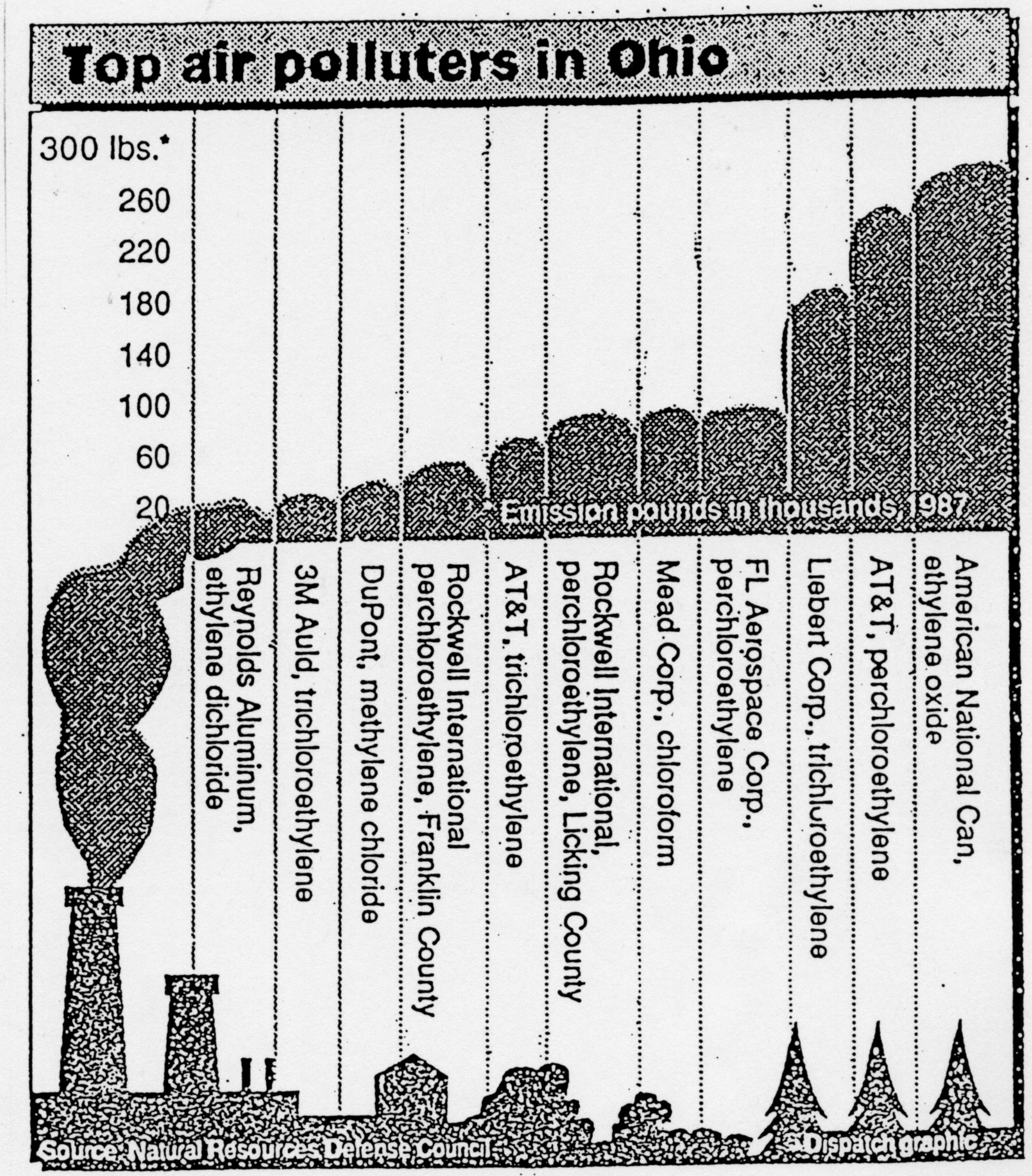
Source: AT&T Columbus Works

Exhibit 3: Quality Architecture Organizational Structure



Source: AT&T Columbus Works

Exhibit 4: Newspaper Chart Depicting Top Ohio Air Polluters



Source: The Columbus Dispatch

Exhibit 5: Perchloroethylene Material Safety Data Sheet Summary

Physical/Chemical Properties:

Appearance:	Colorless liquid
Odor:	Ether-like
Boiling Point:	250 F (121.1 C)

Health Hazard Information:

Eye: May cause pain. May cause slight temporary eye irritation.

Skin: Prolonged or repeated exposure may cause skin irritation, even a burn. Repeated contact may cause drying or flaking of skin.

Inhalation: In confined or poorly ventilated areas vapors can readily accumulate and can cause unconsciousness and death. Dizziness may occur at 200 ppm; progressively higher levels may also cause nasal irritation, nausea, incoordination, drunkenness; and over 1000 ppm, unconsciousness and death.

Cancer information: This chemical is listed as a potential carcinogen. PCE has been shown to increase the rate of spontaneously occurring malignant tumors in certain laboratory rats and mice.

Teratology (birth defects): Birth defects are unlikely. Exposures having no effect on the mother should have no effect on the fetus.

Disposal Considerations:

Any disposal practice must be in compliance with all federal, state/provincial and local laws and regulations. Keep material in closed containers. Do not allow into any sewers, on the ground or into any body of water. Do not allow into municipal waste systems. Do not allow into public water supplies. Do not landfill. The preferred waste management options are to sent to a properly licensed or permitted recycler, reclaimer or incinerator.

Regulatory Information:

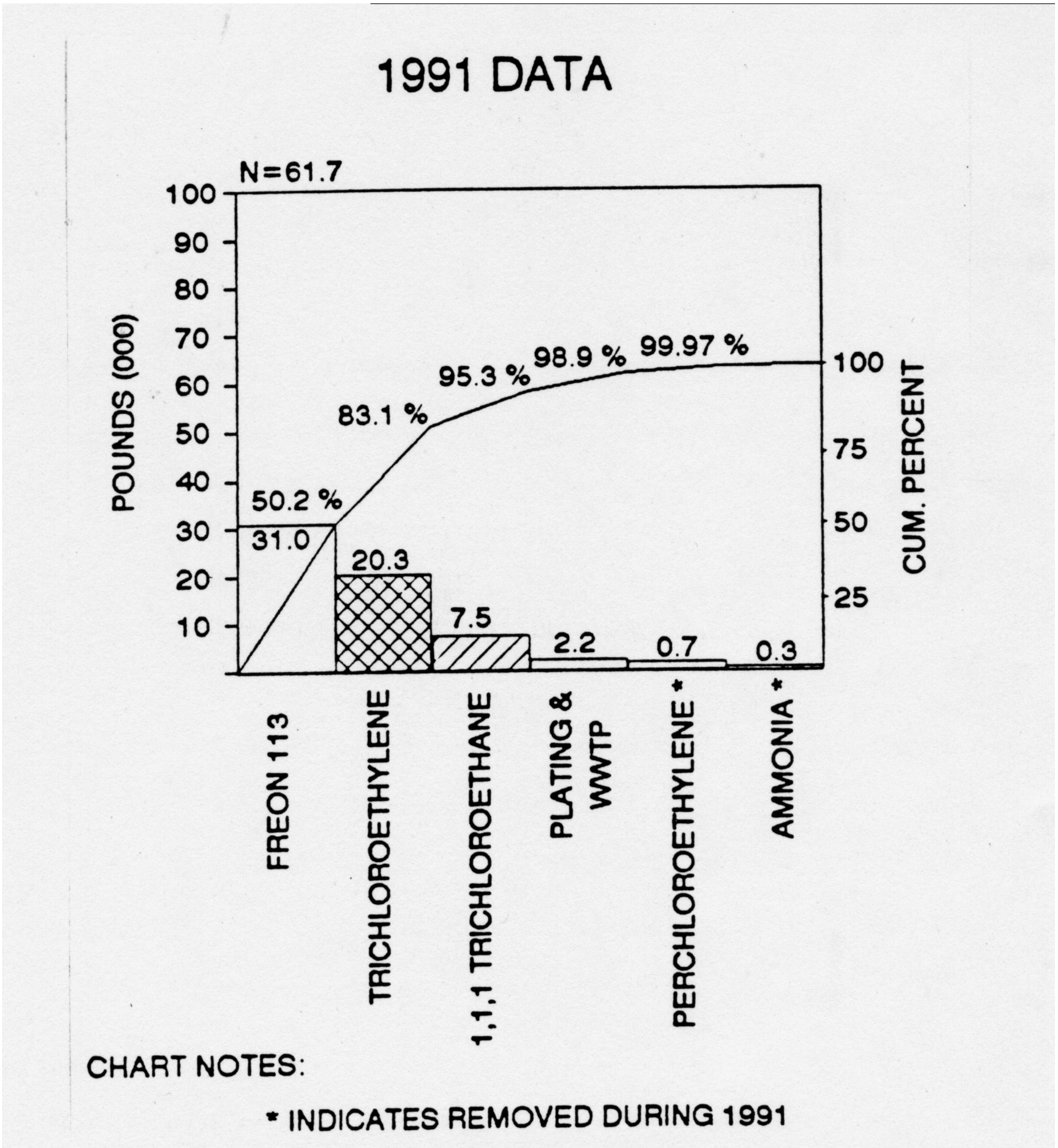
SARA Title III: This substance is subject to the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986.

SARA Hazard Category: This product is considered to meet the following categories:

X An immediate health hazard
X A delayed health hazard.

Source: Dow Chemical Company, Material Safety Data Sheet

Exhibit 6: Columbus Works 1991 Toxic Air Emissions



Source: AT&T Columbus Works

Exhibit 7: 1,1,1 Trichloroethane (TCA) Material Safety Data Sheet Summary

Physical/Chemical Properties:

Appearance:	Colorless liquid
Odor:	Irritating odor at high concentrations
Boiling Point:	165 F (74 C)

Health Hazard Information:

Eye: May cause pain. May cause slight temporary eye irritation with slight temporary corneal injury.

Skin: Prolonged or repeated exposure may cause skin irritation. Repeated contact may cause drying or flaking of skin.

Inhalation: Minimal anesthetic or narcotic effects may be seen in the range of 500-1000 ppm. Progressively higher levels over 1000 ppm may cause dizziness, drunkenness; concentrations as low as 10,000 ppm can cause unconsciousness and death. These high levels may also cause cardiac arrhythmias (irregular heartbeats). In confined or poorly ventilated areas, vapors which readily accumulate can cause unconsciousness and death.

Teratology (birth defects): Birth defects are unlikely. Exposures having no effect on the mother should have no effect on the fetus. In animal studies, has been shown not to interfere with reproduction. Results of in-vitro (test tube) mutagenicity tests have been negative.

Disposal Considerations:

The preferred options for disposal are to send to a licensed reclaimer, or to permitted incinerators. Any disposal practice must be in compliance with federal, state and local laws and regulations. Do not dump into sewers, on the ground or into any body of water.

Regulatory Information:

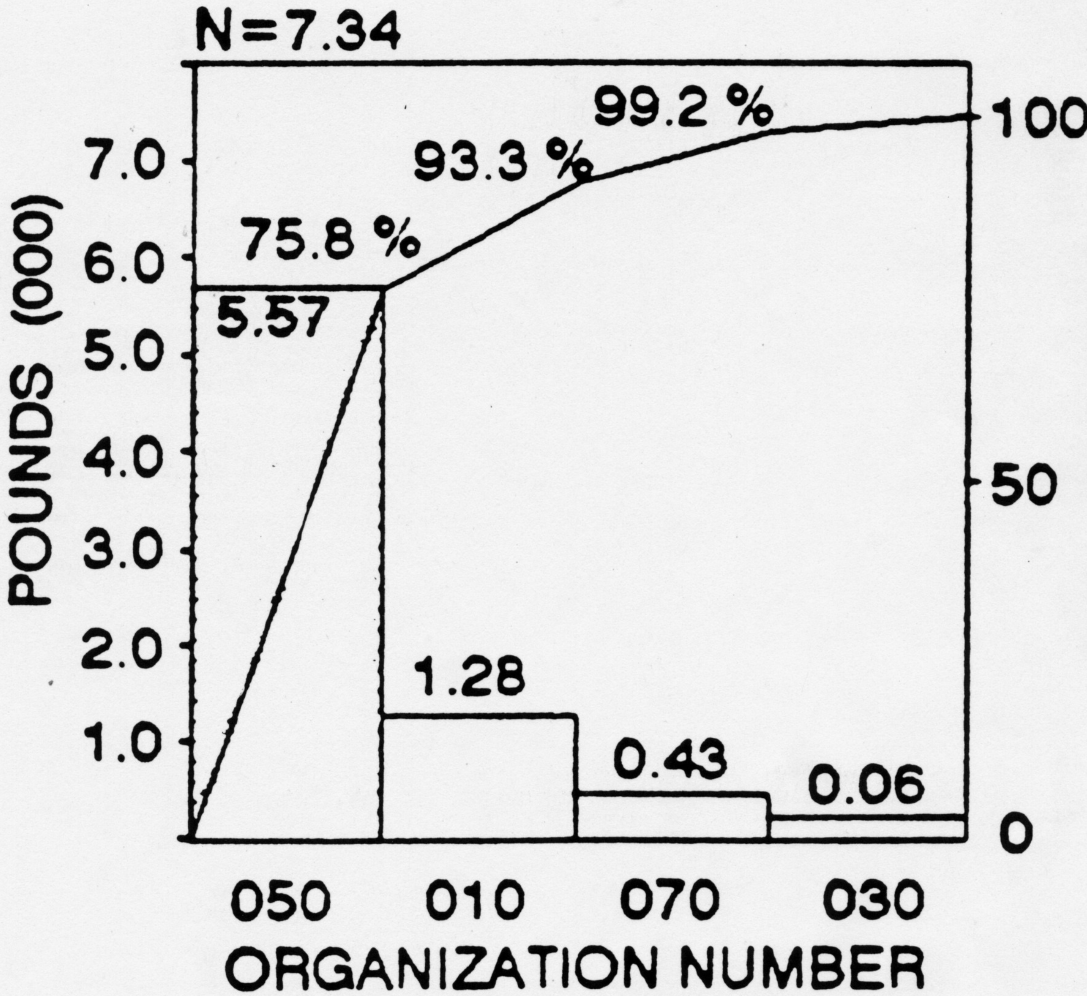
SARA Title III: This substance is subject to the reporting requirements of Title III of the Superfund Amendments and Reauthorization Act of 1986.

SARA Hazard Category: This product is considered to meet the following categories:

X An immediate health hazard.

Source: Dow Chemical Company, Material Safety Data Sheet

Exhibit 8: Columbus Works 1991 TCA Emissions by Organization



Source: AT&T Columbus Works

Exhibit 9: TCA Usage Chart at Columbus Works

Business Unit	Shop	TCA Use	Status
50-Switching	Assembly	Cleaning ink on stamps and rollers used to mark codes on circuit boards	Substitute Butyl Carbitol by 1992
50-Switching	Circuit-pack Repairs	Clean products that fail testing	Stopped cleaning as a routine; reduced use 98% by 1992
50-Switching	Circuit-pack Repairs	Lubricating "goldfingers" on circuit boards	Substitute Butyl Carbitol when receive new dryer
10-Maintenance	Tool Room/Machine Maintenance	Cleaning and degreasing equipment for repair	Substitute with detergent cleaner
50-Switching	Miniature Wire-Spring Relay	Flux removal, cleaning and degreasing of wire-spring relay	Investigating substitutes with Bell Laboratories
50-Switching	Circuit-pack & Wiring Equipment Testing	TCA sprayed to clean and degrease equipment	Investigating substitutes with suppliers; maybe HCFC or Butyl Carbitol

Source: AT&T Columbus Works