DESIGN FOR ENVIRONMENT REPORT 2013

ELECTRONICS PRODUCT STEWARDSHIP CANADA

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Message from Electronics Product Stewardship Canada (EPSC)

EPSC is proud to release this year's Design for Environment Report. This report examines electronics end-of-life issues, including how design changes are impacting recycling, what happens to the valuable materials they contain, and how those materials are changing. We also examine how manufacturers are progressing on "closed loop" systems.

At over five kilograms per capita, Canada is leading the world in electronics diversion from landfill into recycling and reuse. Our industry has also reduced the weight of electronics dramatically as innovation and improved technology have advanced the ability to provide more functionality with fewer materials.

Manufacturers recognize the importance of conserving and reusing materials for future use, with many implementing elements of closed loop systems in their manufacturing processes. At the same time, new recycling technologies are being developed to efficiently and effectively capture more materials.

There are a number of drivers that promote responsible electronics recycling. International regulations like the Basel Convention ensure that hazardous waste is not shipped to developing countries, and economic instruments like high landfill tipping fees promote material recovery, as do landfill bans.

This report illustrates what happens to electronics after they are sent for recycling. It examines what materials are contained in these products, and how materials are recovered and reused. It also highlights the changes being made by the electronics industry which impact recycling.

Shelagh Kerr
PRESIDENT AND CEO

Lloyd Bryant
CHAIR OF THE BOARD

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How Design Changes Impact Recycling

What materials are in electronics?

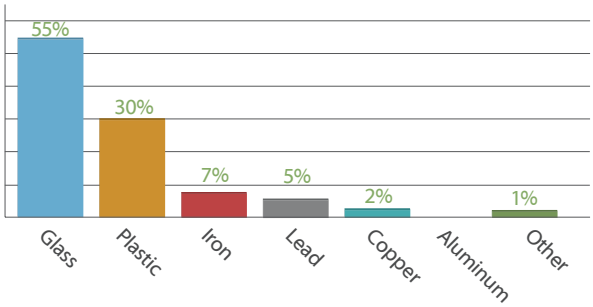
As technology and the functionality of electronics change, so too do the materials they contain. For example, changes in television design have meant that the need for leaded glass has been eliminated. CRT technology, which used leaded glass, has been displaced in the market by liquid crystal display (LCD), light-emitting diode (LED), and plasma displays.

For many years, CRTs were the primary display technology, used in everything from television and computer screens to diagnostic equipment displays. Newer LCD, LED, and plasma technologies are more compact and use less energy. As new CRT displays have been the primary destination for recovered CRT glass, the end-use markets for CRT glass have decreased considerably.

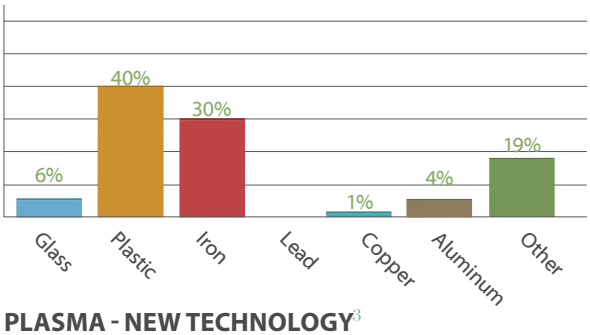
Changing Material Composition of Televisions

DESIGN CHANGES HAVE ELIMINATED THE USE OF LEAD IN TELEVISIONS.

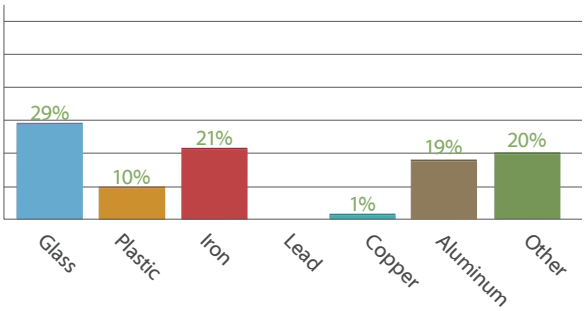
CATHODE RAY TUBE (CRT) - OLD TECHNOLOGY[1]



LIQUID CRYSTAL DISPLAY (LCD) - NEW TECHNOLOGY[2]



PLASMA - NEW TECHNOLOGY[3]



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Modern electronics can contain up to 60 different materials, including iron, aluminium, copper, gold, silver, platinum, palladium, indium, gallium and rare earth metals.[4] These materials are well-suited for use in electronics because of their unique electrical and magnetic properties. For instance, ruthenium is used for its magnetic properties in hard disks, and antimony is used as a flame retardant.[5] Demand for these materials is growing, not only because of increased sales, but also because increasingly multifunctional devices require a wider range of materials.

The mining required to produce these metals has significant social and environmental impacts. Recovering metals from effective and responsible recycling, or "urban mining", helps offset these impacts as it requires significantly less resources and energy. Urban mining also offers substantial benefits with respect to the reduction of greenhouse gas and hazardous emissions, as well as the protection and conservation of the natural environment.

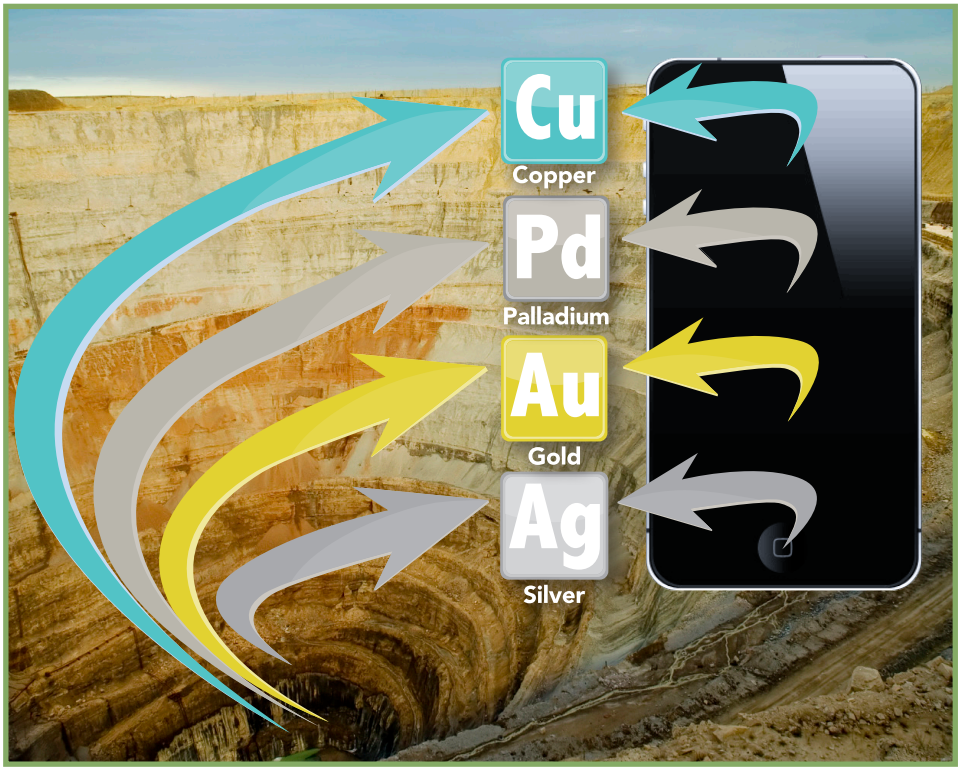
For example, it is estimated that from 50,000 mobile phones, it is possible to recycle around one kilogram of gold, 400 grams of palladium, 10 kilograms of silver, and 420 kilograms of copper. In contrast, extracting one kilogram of gold from a mine below ground requires the removal of 200 tons of rock and generates nearly 10,000 tonnes of CO2 emissions.[6,7]

ABOUT **25%** OF THE ANNUAL PRODUCTION OF SILVER AND GOLD AND **65%** OF PALLADIUM AND PLATINUM ORIGINATES FROM END-OF-LIFE RECYCLABLES.[8]

Urban Mining

IT IS ESTIMATED THAT ABOUT **80%** OF THE COPPER THAT HAS BEEN MINED OVER THE CENTURIES IS STILL IN CIRCULATION[9]

Resources Recovered through Urban Mining



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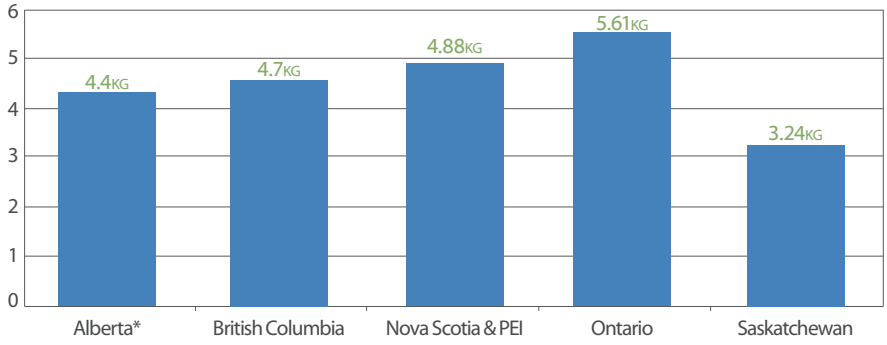
What materials are being recycled?

Since their inception over the past 6 years, Canadian electronics stewardship programs have collected nearly 360,000 tonnes of end-of-life electronics, including computers, printers, televisions, mobile phones, and audio/video devices. These electronics contain a variety of recyclable materials, many of which are valuable and can be sold for reuse. Copper, aluminum, and steel are several examples of high-value materials contained in electronics.[10]

Canadian Electronics Stewardship Programs: Collection Statistics[11]



*ARMA is a government-run program

SINCE THEIR INCEPTION, OVER THE PAST 6 YEARS, CANADIAN ELECTRONICS STEWARDSHIP PROGRAMS HAVE COLLECTED NEARLY 360,000 TONNES OF END-OF-LIFE ELECTRONICS.

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This chart illustrates the types of materials contained in old and new electronics. While older technology is currently being returned for recycling, today's newly marketed electronics will be returned for recycling in the future. These new electronics contain fewer substances of concern, such as lead.

Material Composition of Computers, Mobiles Phones, and Televisions

OLD TECHNOLOGY | **NEW TECHNOLOGY**

DESKTOP COMPUTER[12]
27 KILOGRAMS

- Silica/glass: 25%
- Plastic: 23%
- Iron: 21%
- Aluminium: 14%
- Copper: 7%
- Lead: 6%
- Zinc: 2%
- Tin: 1%
- Other: 1%

LAPTOP[13,14]
2.9 KILOGRAMS

- Metal (ferrous and non-ferrous): 34%
- Plastic: 25%
- Glass: 13%
- Cobalt: 13%
- Other: 15%

NEW ELECTRONICS HAVE ELIMINATED THE NEED FOR LEAD AND GREATLY REDUCED THE USE OF MERCURY.

SECOND GENERATION MOBILE PHONE[15]
136 GRAMS

- Plastic: 34%
- Tin: 7%
- Steel: 9%
- Copper: 10%
- Ferrites: 6%
- Glass/fiber: 5%
- Nickel/lithium oxides: 3%
- Epoxy resin: 3%
- Epoxy (liquid): 2%
- Rubber: 2%
- Other: 19%

SMARTPHONE[16]
110 GRAMS

- Metal (ferrous and non-ferrous): 44%
- Plastic: 32%
- Battery 15%
- Glass/ceramics: 8%
- Other: 1%

CRT TELEVISION[17]
36.7 KILOGRAMS

- Glass: 55%
- Plastic: 30%
- Iron: 7%
- Lead: 5%
- Copper: 2%
- Other: 1%

LCD TELEVISION[18]
6.7 KILOGRAMS

- Plastic: 40%
- Iron: 30%
- Glass: 6%
- Aluminum: 4%
- Copper: 1%
- Other: 19%

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Electronics Recycling Process[19]

Once collected, responsible treatment involves multiple steps designed to maximize the recovery of the cleanest materials possible to be fed back into new manufacturing processes.

- After they are consolidated and sorted, some products are dismantled by hand to remove materials such as hard drives and batteries
- Materials ready for processing are broken down through an initial size reduction process
- The materials drop onto a large shaking hopper, which spaces the material as it drops onto the conveyor belt
- Materials pass through a secondary size reduction process to free materials for downstream separation
- Overhead magnets collect iron and steel components from the waste stream – this material is collected and prepared for sale
- Eddy currents are used to separate aluminum, copper, and brass (non-ferrous) metals from material with low or non-metallic content such as wire, plastic, and printed circuit boards
- Plastics and glass are separated from printed circuit boards and copper wire –circuit boards and copper are collected and prepared for sale

SWEEP RECYCLING VIDEO http://www.youtube.com/watch?v=ymP1129aBgU

sweep POWERED by epra

Copper Pipes

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Importance of Conserving and Reusing Materials

Material recovered from the recycling process includes steel, aluminum, copper, lead, precious metals, glass and plastics.

Clean steel can be sent to a steel mill, and clean aluminum can be sent to a smelter.[20] If these metals are contaminated or require further processing, they are sent to a metal processor.[21] Plastics are sorted, shredded, turned into pellets and recycled.[22] Glass is smelted to be used in glass production and the lead is separated out to be sold as a commodity.

Copper and precious metals offer the highest return for processors.[23] This material is sent to smelting and refining processors such as Xstrata in New Brunswick or Teck in British Columbia.[24]

By reusing materials recovered from the recycling process, environmental impacts resulting from mining and energy use are minimized. These materials are also diverted from landfill, which reduces potential health risks and conserves the natural environment.

Recovery

In 2011, Teck's operations in Trail, BC processed 15,600 tonnes of end-of-life electronics, bringing the total to 50,000 tonnes recycled since 2006.[25] Teck recently invested $210 million in their Trail operations to increase their capacity to recycle end-of-life electronics.[26]

Xstrata's Horne Smelter, Canada's only remaining copper smelter, processed 127,630 tonnes of recycled material in 2010, which yielded 35,500 tonnes of metals.[27] The smelter uses both copper concentrates and precious-metal-bearing recycable materials as its feedstock to produce a 99.1% copper anode.[28]

Markets for Recovered Materials

The world's end-of-life electronics offer a potential material resource of an estimated 40 million tonnes each year.[29] Many materials recovered from responsible electronics recycling can be used as feedstock in different processes. While these materials may not necessarily go back into the electronics manufacturing stream, plastics, glass, and metals are turned back into commodity grade materials and incorporated into useful products.

Xtrata, smelter

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Closed Loop Systems

A closed loop system refers to using recycled and reclaimed material to create new products of the same type. Achieving true closed loop systems in electronics manufacturing is challenging because electronic products often contain a variety of complex components and materials with stringent performance requirements. Additionally, these materials can be used in numerous combinations which can complicate the recovery process.[30]

Despite the challenges, a number of companies are implementing elements of closed loop systems in their manufacturing processes, which provide an important use for responsibly recycled materials from end-of-life electronic products.

HP Planet Partners return and recycling program, for example, takes back all brands of used electronic equipment and HP ink and Laser Jet cartridges. In 2012, 18.8 million pounds of recycled plastic was used in new HP ink and Laser Jet cartridges.[31] HP has produced more than 1.5 billion Original HP ink and Laser Jet toner cartridges containing content from this closed loop recycling process.[32] Recycled plastic used in HP ink cartridges has up to a 33% lower carbon footprint, consumes more than 60% less fossil fuel, and uses up to 89% less water.[33]

Closed Loop

CLOSED LOOP SYSTEMS PROVIDE AN IMPORTANT USE FOR RESPONSIBLY RECYCLED MATERIALS FROM END-OF-LIFE ELECTRONICS

Panasonic. At Panasonic's Eco Technology Center (PETEC), work is underway to achieve 'from products to products recycling' by recovering materials that can be processed and reused in new products.[34] This type of recycling helps realize zero waste by creating a raw material cycle of production, use, return, and utilize.[35] PETEC's research and development division accomplishes this goal by developing new recycling technologies and supporting design for recycling initiatives.[36]

Dell is also working to help close the recycling loop by incorporating recycled-content plastics into their products whenever possible. In 2011, Dell used 7.4 million pounds of recycled-content plastics in Dell OptiPlex desktops and flat-panel monitors.[37] If lined up end to end, the recycled plastic content equivalent of 20 oz. water battles would stretch over 24 thousand miles.

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Canada's Success in Electronics Stewardship

Canada is a world leader in electronics stewardship. At over five kilograms, Canada's per capita volume of comparable recycled electronics surpasses that of the United States, as well as many European countries. Canada's provincial electronics stewardship programs continue to make great strides. Together, they have diverted roughly 360,000 tonnes of electronics from landfill since their inception.

The challenges facing responsible electronics recycling will continue as more products with increasingly complex designs and a greater range of materials reach market. However, with appropriate programs governing end-of-life electronics recycling, an innovative and engaged manufacturer community, and forward-thinking requirements like those included in the Electronics Recycling Standard, Canada is well-positioned to continue its global leadership in electronics stewardship.

Drivers of Responsible Electronics Recycling

EPSC Recycling Standard

THE ELIMINATION OF POLYBROMINATED DIPHENYL ETHERS (PBDEs), A SUBSTANCE OF CONCERN FOUND IN ELECTRONICS, IS YIELDING POSITIVE ENVIROMENTAL IMPACTS. ACCORDING TO ENVIROMENT CANADA, CONCENTRATIONS OF PBDEs ARE DECLINING IN THE ENVIROMENT AND HAVE ONLY BEEN FOUND IN VERY LOW LEVELS IN LANDFILL LEACHATE.[40]

One of the first and highest standards for electronics recycling in the world, the Electronics Recycling Standard (ERS) was created by EPSC members to define the requirements for safe and responsible handling of end-of-life electronics. These requirements ensure that end-of-life electronics are managed in an environmentally sound manner that safeguards worker health and safety and the environment. The ERS meets or exceeds the current environmental, health and safety regulations and standards in Canada, making Canada a world leader in creating and applying such a standard. All processors participating in provincial electronics stewardship programs must meet the requirements of the ERS.

Recycler Qualification Office

The Recycler Qualification Office (RQO) works to ensure that only qualified recyclers meeting the high standards laid out in EPSC's Recycling Standard are approved to handle electronic waste across Canada.[38] All processors working with provincial electronics stewardship programs must receive RQO verification that they meet the EPSC Recycling Standard. A list of RQO approved processors and refurbishers is available on the RQO website: www.rqp.ca.

Landfill Bans

Landfill bans are necessary to keep end-of-life electronics out of landfills. Currently, the cost to recycle electronics in Canada is almost four times more expensive than the cost of landfilling.[39]

Landfill bans on electronics can be used to divert this material from landfill and encourage material recovery. To date, three provinces and a handful of regions have implemented landfill bans on electronics.

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Examples of Canadian Regions with Electronics Landfill Bans[41]

Canadian and International Regulations

Extended Producer Responsibility Legislation

The Canadian Council of Ministers of the Environment defines extended producer responsibility as "an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle."[42]

In extended producer responsibility arrangements for Waste Electrical and Electronic Equipment (WEEE), responsibility for end-of-life management of electronic products is transferred from taxpayers to producers. These costs are generally passed on, particularly for consumer products, through Environmental Handling Fees. Extended producer responsibility programs for WEEE have been established by provincial legislation in nine provinces to date.

Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal

In Canada, sending hazardous WEEE to developing countries for processing is illegal. As a signatory to the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal, Canada is committed to managing hazardous waste in a responsible manner that does not harm human health or the environment.

BASEL CONVENTION

The Basel Convention is an international treaty designed to minimize transboundary movements of hazardous waste and promote environmentally sound management by establishing guidelines to ensure proper disposal. The overarching objective of the Basel Convention is "to protect human health and the environment against the adverse effects of hazardous wastes."[43]

PACE
Partnership for Action on Computing Equipment

In 2008, the Partnership for Action on Computing Equipment (PACE) was established at the Ninth Conference of the Parties to the Basel Convention. PACE is a multi-stakeholder partnership, involving many EPSC members, which works to increase the environmentally sound management of used and end-of-life computing equipment.[44]

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Drivers of End-of-Life Impact

Restriction of Hazardous Substances (RoHS) Directive

Adopted by the European Union, this directive restricts the use of six hazardous materials in electronics:

Lead	• Phased out, through shift from CRT to LED TVs
Mercury	• Phased out, LEDs do not need mercury
Cadmium	• Phased out, except in rechargeable batteries
Hexavalent Chromium	• Phased out
Polybrominated Biphenyls (PBB)	• Flame retardants are being eliminated as replacements are developed
Polybrominated Diphenyl Ether (PBDE)	• Flame retardants are being eliminated as replacements are developed

Because most electronics are manufactured for worldwide distribution, regulations like RoHS are significant drivers for reducing and eliminating environmentally sensitive materials in electronic products sold in Canada.

epeat BRONZE
MEETS ALL REQUIRED CRITERIA

epeat SILVER
MEETS ALL REQUIRED CRITERIA PLUS AT LEAST 50% OF THE OPTIONAL CRITERIA

epeat GOLD
MEETS ALL REQUIRED CRITERIA PLUS AT LEAST 75% OF THE OPTIONAL CRITERIA

EPEAT

As a comprehensive design standard, EPEAT (Electronic Product Environmental Assessment Tool) promotes improvements in product sustainability and energy use. EPEAT's rating system enables consumers to view and compare the environmental performance of electronic products throughout their life cycle. The criteria used by EPEAT address:

- Reduction/elimination of environmentally sensitive materials
- Material selection
- Design for end of life
- Product longevity/life extension
- Energy conservation
- End-of-life management
- Corporate performance
- Packaging[45]

Products must meet all required criteria to qualify for EPEAT's Bronze-level certification. Depending on the number of optional criteria a product meets, it can qualify for Silver or Gold-level certification.

Currently, EPEAT applies to desktop computers, notebooks, workstations, thin clients, monitors, printers, copiers, scanners, multifunction devices, fax machines, digital duplicators, mailing machines, and televisions.[46]

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About EPSC

Electronics Product Stewardship Canada (EPSC) is a not-for-profit, industry-led organization working to represent the interests of electronics manufacturers for innovation in enhanced end-of-life solutions for electronic products in Canada. Its membership is comprised of over 30 leading Canadian electronics manufacturers and trade associations. EPSC members have shown environmental leadership by working with stakeholders to create effective industry-led environmental stewardship programs across Canada, by investing in design improvements to their products and processes, and by establishing an innovative vendor qualification program for the responsible recycling of end-of-life electronics.

EPSC Members

- Apple Canada Inc.
- Asus
- BenQ America Corp.
- Brother International Corporation (Canada) Ltd.
- Canon Canada Inc.
- Ciaratech
- Cisco Systems Inc.
- Dell Canada Inc.
- Electro-Federation Canada
- Epson of America Inc.
- Fujitsu Canada Inc.
- General Dynamics Itronix
- Getac
- Hewlett-Packard (Canada) Co.
- Hitachi Data Systems Inc.
- IBM Canada Ltd.
- Information Technology Association of Canada
- LG Electronics Canada Inc.
- Lenovo Canada Inc.
- Lexmark Canada Inc.
- Microsoft Corporation
- NetApp Inc.
- Northern Micro Inc.
- Oracle America Inc.
- Panasonic Canada Inc.
- MMD-Philips
- Samsung Electronics Canada Inc.
- Sony of Canada Ltd.
- Toshiba of Canada Ltd.
- Xerox Canada Ltd.
- Xplore Technologies Corporation

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Endnotes

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