**Project Report:**

# Life Cycle & Risk Assessment of Receipt Paper


Ben Lipovski

School of Population and Public Health, University of British Columbia


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Dr. Robert Macpherson

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## Preface

This project report provides a comprehensive summary of the contents found on spph.lipovski.ca, a website hosting my risk assessment project focused on analyzing receipt paper. This document aims to convey the information available on the website, though it excludes some details that are pertinent solely to the website's context. Given that the website's content is distributed across several pages, this document serves to consolidate my work in a single location.

# I. Introduction

Before we delve into the details of receipt paper, it's crucial to understand how this website is organized. The site is designed with a documentation-style approach, organizing information in a clear and linear progression. The project is divided into four main sections: (1) introduction, (2) background, (3) life cycle assessment, and (4) risk assessment.

For smooth navigation, you will find previous and next buttons at the bottom of each page. To quickly move across different topics, use the sidebar on the left or the buttons on the homepage of each section, such as listed below. At any point, you can return to the homepage by clicking *SPPH 381E* on the website's header.

## The Paper Trail Begins

In the vast landscape of consumerism, paper receipts hold a crucial place in the routine functioning of business transactions. Used across various sectors, such as grocery stores, banking, restaurants, and gas stations, receipts have become an omnipresent component of modern commerce. Receipts, valued for their fast and legible printing, play a crucial role in personal and commercial accounting. Although Canada does not have explicit legislation mandating receipts [1,2], it has become a widely adopted practice, effectively making it a de facto standard.

With receipts being produced for every transaction, we have become inundated with a constant stream of paper, contributing to environmental concerns and clutter in our daily lives. Given that Canada processes around 30 million financial transactions daily [3], it is difficult to quantify the number of receipts produced. Highlighting the broader context, the global market for receipt paper was estimated at USD 4.16 billion in 2023 [4], demonstrating the vast consumption and environmental footprint of transactions worldwide. Transitioning from the scale of consumption to its environmental implications, the life cycle of receipt paper offers insight into the multifaceted impacts and risks of this ubiquitous product.

This project examines the lifecycle of receipt paper, from resource extraction through to disposal. Concurrently, this project aims to perform an in-depth risk assessment of occupational hazards throughout each phase and analyze the effectiveness of current hazard control measures. The aim of this project is to illuminate the environmental and health implications of receipt paper production and use, guiding more sustainable practices and risk mitigation strategies.

## Key Definitions

### *What is Receipt Paper?*

A point-of-sales (POS) receipt is a document acknowledging that a person has received money or property in payment following a sale or other transfer of goods or provision of a service [1,2]. It serves as proof of transaction and typically includes details such as the date of purchase, the items purchased, their prices, the total amount paid, and the seller's information [2]. Unlike other receipts, such as invoices which are issued prior to payment as a request for payment, or e-receipts sent digitally to customers [5], POS receipts are tangible proof provided immediately after a purchase [1].

> In this project, the term 'receipt paper' will be consistently used to denote the specific type of thermally activated paper utilized for POS-prompted receipts.

Receipt paper is the specialized paper used for printing receipts, with thermal paper being the most commonly used type [6,7]. This technology is also employed in thermal barcode labels, shipping labels, and other applications requiring quick and durable printing solutions [6,7].

### *Comparison to Traditional Paper*

Receipt paper is the specialized paper used for printing receipts, with thermal paper being the most commonly used type [6,7]. Designed to be cost-effective for businesses requiring swift, ink-free printing, receipt paper is available in rolls, making it easily adaptable to the high-volume demands of retail and service industry transactions [7]. However, its chemical coating poses environmental recycling challenges, contrasting with the more straightforward, eco-friendly recycling of regular paper [5,8]—a subject that will be further addressed later in this project.

## II. Background

Before delving into the main topics of this project, it is important to understand the chemistry of receipt paper.

### Anatomy

Receipt paper uses a thermochromic process for inkless printing, achieved through its multi-layered composition [6,7]. These layers, outlined below, work in tandem to ensure the print's durability and clarity [6].

#### *Topcoat*

The topcoat on receipt paper, also known as the protective layer, is applied over the thermal coating to protect the thermally sensitive layer from environmental factors, abrasion, and other physical damages that could affect the print quality and longevity [7,9].

#### *Thermal Layer*

At its core, the thermal layer contains a mix of active agents that undergo a colour-changing process when exposed to heat [7,9–12]. The next section explores the layer in greater detail.

#### *Precoat*

The precoat is the coating between the base paper and the thermal-sensitive layer, smoothing the base paper's surface for a uniform and precise interaction with the thermal printhead [7,9].

#### *Base Paper*

The base paper makes up the actual paper part of the receipt, offering the essential stability, durability, and specific physical qualities needed for thermal printing [7,9].

***Backcoat***

The backcoat functions as a protective layer, increasing durability and offering protection from physical and environmental damage [7,9].

The image below provides a visual representation of the layers and their respective proportions.

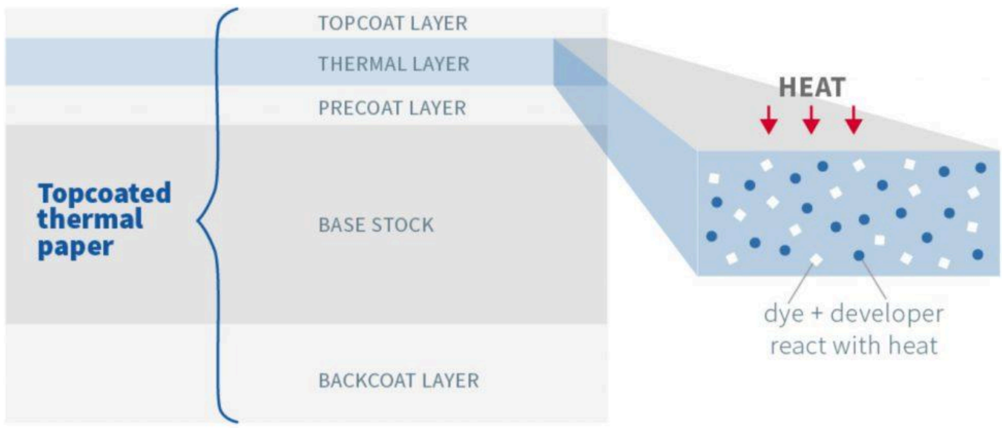
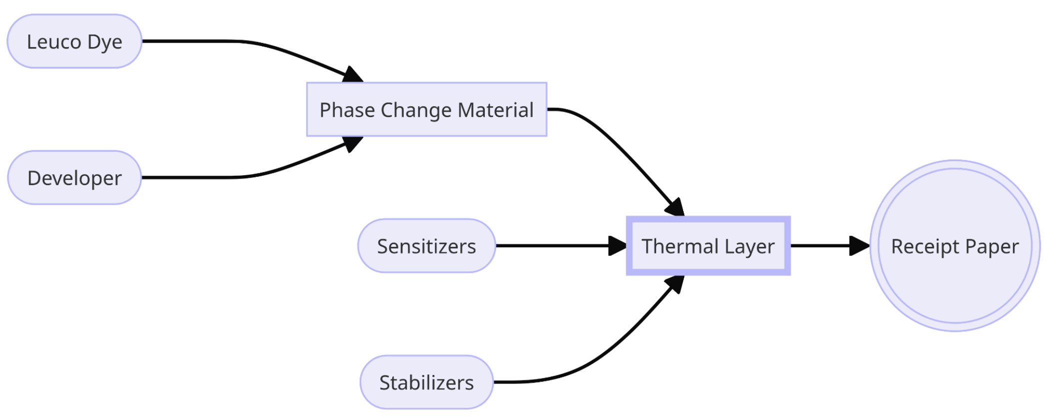



*Image Courtesy of Jujo Thermal*

Next, we will delve into the mechanism responsible for the colour change in receipt paper.

**Key Chemicals**



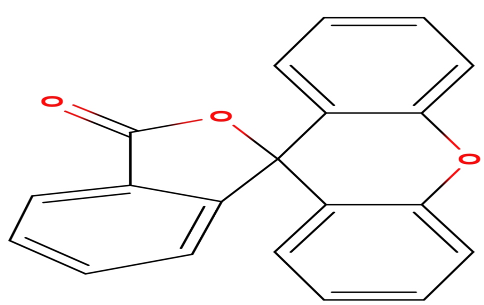

*Flowchart created with Mermaid*

Within the thermal layer, five chemical components facilitate a reaction when the receipt paper is exposed to heat [7,9]. The most critical of these are the leuco dye, developer, and phase change materials [7,9–12].

The chemicals listed are among the most commonly used in the industry. Note that the precise composition may vary between products and manufacturers.

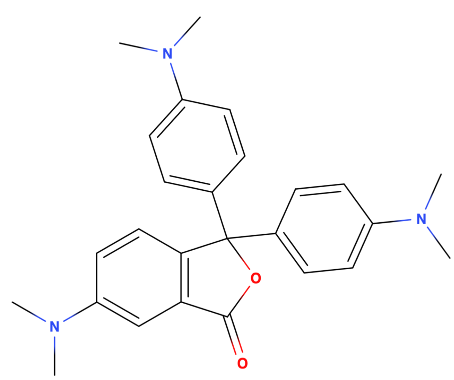
***Leuco Dyes***

Leuco Dyes are colourless (or nearly colourless) compounds that can be transformed into a coloured state by a chemical reaction [9,10]. In thermal paper, leuco dyes develop colour when they react with developers [9,10]. The colour change typically occurs because of a structural change in the dye molecule, which alters the way it absorbs and reflects light [9,10].




**Fluoran**

Fluoran is a broad category of leuco dyes that can produce typically black or blue [13].

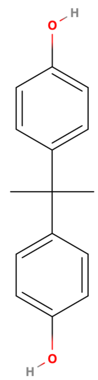



**Crystal Violet Lactone (CVL)**

CVL is a triphenylmethane leuco dye that is used to produce blue or violet [14].

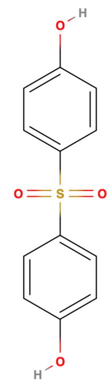
*Developers*

Developers trigger the colour change process by chemically reacting with the leuco dye [7–9]. Upon the application of heat, the encapsulating medium (see below) melts, releasing the developers to react with the leuco dye [7–9].




**Bisphenol A (BPA)**

BPA is a common and easily produced industrial chemical with acidic properties [15].




**Bisphenol S (BPS)**

BPS is a chemical alternative to BPA with similar acidic properties [16].

*Phase Change Materials (PCM)*

Phase change materials serve as the medium within which the leuco dye and developer are embedded [7,9]. When heat is applied, it melts, allowing a reaction between the leuco dye and the developer. A commonly used PCM is paraffin wax [7,9].

Next, we will explore the colour-changing reaction that occurs between these critical chemicals.

**Thermochromic Reaction**

Within the receipt printer apparatus, the thermal printhead generates heat in a precise pattern corresponding to the specified text or images [7,9]. Heat is applied directly to the thermal receipt paper as it passes under the printhead [7,9]. This localized heating is the trigger for the subsequent chemical reactions in the coated layer of the paper, starting the colour development process in specific areas to create the desired print [7,9,10].

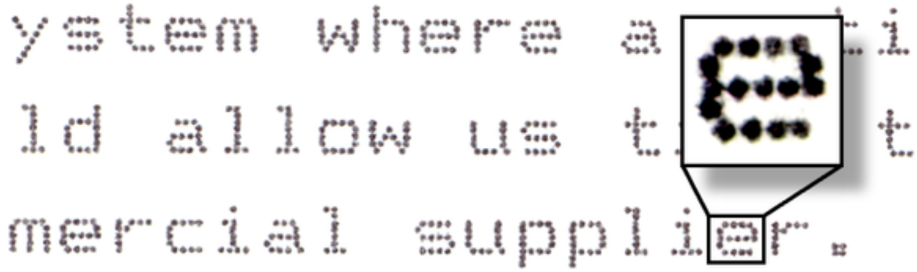



*Image Courtesy of Fourohfour from Wikimedia*

***PCM Melting***

The PCM melts when exposed to the heat from the printhead [7,9]. As the leuco dye and developer are suspended in the PCM, they cannot interact [7,9].

***Thermochromic Reaction***

The developer, which is commonly BPA or BPS [17,18], has acidic properties that trigger a phase change in the leuco dye [7,9]. This event, called protonation, involves the developer donating hydrogen ions (protons) to the leuco dye [9–12]. Adding a hydrogen ion changes the leuco dye's structure, altering how the molecule interacts with light and thus its colour [9–12]. This process is called a thermochromic reaction, as it involves a change in colour triggered by temperature changes [9–12]. The exact colour produced depends on the structure of the leuco dye and the nature of the protonation [9,10].

Below is an example of the chemical reaction between the leuco dye fluoran and BPA.

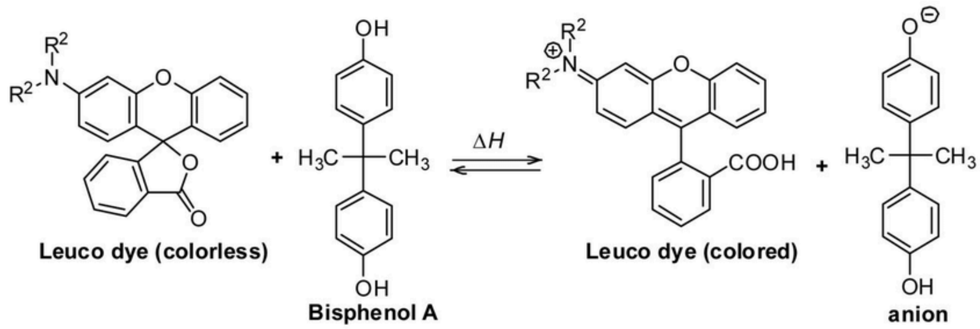



*Image Courtesy of Gogoi & Neog, 2016 [18]*

***Cooling***

After moving beyond the printhead, the PCM cools down and solidifies [7,9]. During this time, the developer and leuco dye are resuspended, albeit in an altered configuration [9,10]. Unless heat is reapplied, printed receipt paper will maintain its chemical integrity [7,9]. Over time, the chemical bonds in the paper start to break down, leading to a gradual fading of the print as its stability decreases [9,10].

## III. Life Cycle Assessment

In the life cycle section of this project, we will explore the main phases of the product's life from a 'cradle to grave' perspective.

### Cradle to the Grave

This life cycle assessment critically examines the environmental footprint of thermal receipt paper from production to disposal [19,20]. This analysis partially uses the framework of ISO standards 14040 and 14044 to ensure a systematic and scientifically rigorous evaluation [19,20].

#### *Resource Extraction*

Receipt paper is primarily made up of petroleum-based products [11,12] and wood pulp [9]. These materials are selected for their ability to interact effectively under thermal stress to ensure the durability and clarity of the print [9,11,12]. Therefore, this stage involves the extraction of essential raw materials, including cellulose from wood pulp [9] and specialized chemicals for the thermal coating [10–12].

#### *Manufacturing*

The manufacturing process of thermal receipt paper comprises multiple phases: the conversion of wood into pulp, paper production, and the addition of the thermal coating [9,10]. During the primary phases of production, the chemicals are synthesized from petroleum-based precursors [9,10]. In the secondary phases, these chemicals are blended to produce the individual layers [9,10]. Finally, these layers are assembled to complete the receipt paper, which is then wound into rolls for distribution [7,9].

***Distribution***

This involves the transportation of the finished thermal receipt paper to various distribution centres and retail outlets [18,21]. The environmental impact of transportation primarily comprises emissions released by transport vehicles and the related consumption of energy [21].

***Use***

The usage phase involves issuing printed receipts to customers. While the direct environmental impact of this phase is minor [21], research has suggested that handling receipt paper exposes both workers and consumers to hazardous concentrations of BPA and BPS [8,17,18,22].

***Disposal***

The end-of-life for thermal receipt paper typically results in it being sent to landfills or undergoing incineration [8,21]. This disposal process has environmental consequences, including the release of chemicals, especially BPA and BPS [8], into soil and groundwater at landfill sites, and emissions generated through incineration [21].

**Reuse & Recycle?**

The chemical coating on receipt paper causes it to be non-recyclable [8,18,21]. The potential for BPA and BPS to leach into the environment poses significant concerns [8,21]. Moreover, the slender nature of the paper and its chemical composition make it unsuitable for conventional recycling processes [8,21].

## IV. Risk Assessment

The life cycle of receipt paper involves various phases, each accompanied by occupational hazards. Below is an analysis of common hazards across different phases of the life cycle, including hazard identification, evaluation, and control measures.

### Resource Extraction

#### *Hazard Identification*

*Chemical Exposure.* Workers can be exposed to volatile organic compounds and other hazardous chemicals found in petroleum products and thermal coating substances [23,24]. Prolonged exposure can lead to respiratory issues, skin irritation, and more severe conditions like chemical pneumonitis [23–25].

*Particulate Matter.* The process of extracting and processing cellulose from wood pulp generates dust and fine particulate matter [26,27]. Inhalation of these particles can lead to respiratory conditions, including chronic bronchitis and lung function impairment [26,27].

#### *Evaluation*

**Level of Risk to Workers.** The risk level of workers extracting petroleum-based agents and wood pulp is especially high [24,27]. For example, workers are at increased risk for cancer, including mesothelioma, prostate cancer, and lung cancer [23–25]. Exposure to hazardous chemicals can lead to respiratory diseases, skin disorders, and other long-term health complications [25].

**Measurement of Risk.**

*Hazard Identification.* Analyzing work processes and potential sources of chemical or physical harm [21].

*Environmental Monitoring.* Sampling air, water, and surfaces for specific chemicals or contaminants [24].

*Biomonitoring.* Measuring levels of substances or their metabolites in workers' bodily fluids (blood, urine) [24].

**Exposure Limits.** One of the key challenges in setting occupational exposure limits (OELs) for petroleum industry workers is the complex mixture of hydrocarbons and other potentially hazardous agents they can be exposed to [28]. For example, hydrogen sulfide and acetone serve as a key precursor in the production of chemicals found in receipt paper, such as BPA and BPS.

**Table 1. Hydrogen Sulfide OELs**

| | Time-Weighted Average (TWA)† Exposure Limit | Workplace Exposure Limit | Reference |
|---|---|---|---|
| **United States**<br>*Occupational Safety and Health Administration (OSHA)* | 20 ppm | 20 ppm | [29] |
| **Canada**<br>*Canadian Centre for Occupational Health and Safety (CCOHS)* | 1 ppm | – | [30] |
| **European Union**<br>*European Chemicals Agency (ECHA)* | 1 ppm‡ | – | [31] |

†Note. *Time-weighted average (TWA) is the average exposure over eight hours.*

‡Note. *The EU does not specify a unified limit, but 1 ppm is widely referenced.*

**Table 2. Acetone OELs**

| | Time-Weighted Average (TWA)† Exposure Limit | Workplace Exposure Limit (WEL) | Reference |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **United States** *Occupational Safety and Health Administration (OSHA)* | 1000 ppm‡ | 3000 ppm | [32] |
| **Canada** *Canadian Centre for Occupational Health and Safety (CCOHS)* | 250 ppm | 500 ppm | [33] |
| **European Union** *European Chemicals Agency (ECHA)* | – | 500 ppm | [34] |

†Note. *Time-weighted average (TWA) is the average exposure over eight hours.*
‡Note. *The California Division of OSHA exposure limit is 500 ppm TWA.*

For wood pulp production and extraction, the following OELs for wood dust are published. Note that different wood species carry unique risks and exposure concerns [35].

**Table 3. Wood Dust OELs**

| | Time-Weighted Average (TWA)† Exposure Limit | Workplace Exposure Limit (WEL) | Reference |
|---|---|---|---|
| **United States** *Occupational Safety and Health Administration (OSHA)* | 5 $mg/m^3$ | 15 $mg/m^3$ | [35] |
| **Canada** *Canadian Centre for Occupational Health and Safety (CCOHS)* | 1–5 $mg/m^3$ | – | [36] |
| **European Union** *European Chemicals Agency (ECHA)* | 2 $mg/m^3$ | – | [37] |

†Note. *Time-weighted average (TWA) is the average exposure over eight hours.*

**Types of Workers Most at Risk.**

*Drilling and fracking crews.* Especially workers with direct exposure to crude oil, hydrogen sulfide, acetone, and fracking chemicals [24].

*Mechanics and maintenance workers.* Workers can be exposed to a wide range of chemicals and physical hazards [24].

*Pulp Mill Workers.* Workers with direct exposure to chemicals used in pulping and bleaching processes [27].

*Transportation workers.* Accidents involving tankers, exposure to hazardous materials, chemical off-gassing during transport of wood pulp, and during loading and unloading [24,27].

**Potential Burden of Injury/Illness.**

*Acute injuries*. Burns, lacerations, crush injuries, respiratory harm from chemical releases or exposure [24,27].

*Chronic illnesses.* Cancers (leukaemia, lung cancer) [38], respiratory diseases (silicosis, COPD, bronchitis) [25], skin conditions (dermatitis, chemical burns) [23,25], neurological disorders [24], asthma and allergic reactions (wood dust, mould) [26].

***Control***

*Elimination and Substitution.* Replacing hazardous chemicals with safer alternatives [24].

*Engineering Controls.* Ventilation systems to reduce airborne contaminants, soundproofing to mitigate exposure [24,27].

*Administrative Controls.* Implementing shift rotations to limit exposure time, proper training on the hazards and safe handling of chemicals [24,28].

*Personal Protective Equipment (PPE).* Gloves, masks, and protective clothing to minimize direct exposure [28].

**Manufacturing**

***Hazard Identification***

*Chemical Exposure.* Many chemicals found in receipt paper pose several hazards during handling. Exposure can occur through contact with the skin, inhalation, or the contamination of non-laboratory items and clothing [18,22].

***Evaluation***

**Level of Risk to Workers.** Manufacturing workers face higher risks compared to those handling receipts, because of the higher concentrations of chemicals and the various potential exposure pathways [38,39].

**Measurement of Risk.**

*Biomonitoring.* The most frequently employed method involves assessing the levels of chemicals in workers' urine or blood [17,40].

*Air Sampling.* Measuring airborne dust levels or any solvents used throughout the processes [8,21].

**Exposure Limits.** As the manufacturing of receipt paper's chemical elements occurs in a laboratory environment, regulators rarely publish specific OELs. Therefore, laboratory chemical safety summary (LCSS) datasheets for the most frequently used chemicals will be consulted for reference.

**Table 4. Laboratory Chemical Safety Summary (LCSS) Datasheet**

| | GHS Pictogram | Hazard Statement‡ | Reference |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Fluoran**† <br> *2-Anilino-3-methyl-6-(dibutyl amino)fluoran* |  | H413 (100%)* | [41] |
| **Crystal Violet Lactone** <br> *3,3-Bis(p-dimethylaminophen yl)-6-dimethylaminophthalid e* |  | H315 (88.39%) <br> H319 (88.39%) <br> H335 (100%) | [42] |
| **Bisphenol A** <br> *2,2-Bis(4-hydroxyphenyl)pro pane* |  | H317 (99.92%) <br> H318 (99.92%) <br> H335 (100%) <br> H360 (19.31%) <br> H361 (79.66%) <br> H411 (12.97%) | [43] |
| **Bisphenol S** <br> *4,4'-Sulfonyldiphenol* |  | H360 (53.91%) <br> H360FD (91.74%) | [44] |

†Note. *As fluoran represents a broad category of compounds, the LCSS for ODB-2 (the most common application) is presented.*

‡Note. *Part of the globally harmonized system of classification and labelling of chemicals (GHS), the hazard statement is a signal word and precautionary risk factor.*

*Note.*The percentage value in parenthesis indicates the notified classification ratio from companies that provide hazard codes.*

**Types of Workers Most at Risk.**

*Machine Operators.* Workers who are directly involved in the coating and drying processes [38,39].

*Maintenance Workers.* Workers who clean and maintain machinery can be exposed to chemical residues [38].

*Quality Control Personnel.* Workers handling precursor agents and receipt paper for testing [38].

**Potential Burden of Injury/Illness.**

*Endocrine disruption.* Especially with BPA and BPS, exposure can affect reproductive health, metabolism, and development [38,45].

*Increased Risk of Cancer.* Research suggests a potential association with breast cancer, prostate cancer, and other forms [17,40].

*Cardiovascular and Metabolic Issues.* Certain chemicals may elevate the risk for heart disease, type 2 diabetes, and obesity [38,39].

### *Control*

*Elimination and Substitution.* Some manufacturers have shifted to alternatives without BPA, BPS, or other phenol-based agents [46]. However, adoption is not universal and is difficult to assess [17,46].

*Engineering Controls.* While well-ventilated work areas, dust collection systems, and enclosed coating processes exist, their effectiveness and consistency remains uncertain for receipt paper's agents [17,46].

*Administrative Controls.* Job rotation, limiting exposure time, and hygiene practices, such as frequent handwashing, are probable measures [17].

*Personal Protective Equipment (PPE).* Gloves and respirators should be (and typically are) standard practice [17,46].

## Distribution & Use

### *Hazard Identification*

*BPA.* BPA can be absorbed through the skin, though exposure is especially concerning when it involves contact with the mouth and nasal passages [22,38,45,47]. This exposure raises health concerns because of BPA's endocrine-disrupting properties, which can interfere with hormonal functions and increase the risk of various health issues, including reproductive problems and diseases [38,45].

*BPS.* BPS is primarily used in "BPA-free" receipt paper [8,40]. Despite being considered a safer alternative to BPA, BPS also exhibits endocrine-disrupting properties, potentially affecting hormonal balance and health, similarly to BPA [17,40].

### *Evaluation*

**Level of Risk to Workers.** The primary concern for workers, particularly cashiers, as well as consumers, is exposure to BPS and BPA through skin contact [17,38,40]. Especially relevant to the COVID-19 pandemic, research has suggested that hand sanitizer increases the permeability of BPA and BPS from thermal receipt paper, introducing an extra hazard [45,48].

**Measurement of Risk.**

*Biomonitoring.* The most direct method is measuring BPA and BPS levels in urine or blood samples of workers [17,40].

*Workplace Sampling.* While less common, it typically involves analyzing receipts themselves to determine BPA and BPS content [17,49].

**Exposure Limits.**

**Table 4. Bisphenol-A OELs**

| | Time-Weighted Average (TWA)† Exposure Limit | Workplace Exposure Limit (WEL) | Reference |
|---|---|---|---|
| **United States** *Occupational Safety and Health Administration (OSHA)* | – | – | [50] |
| **Canada** | 3–10 mg/m$^3$ | – | [51] |

| | | | |
|---|---|---|---|
| *Canadian Centre for Occupational Health and Safety (CCOHS)* | | | |
| **European Union** *European Chemicals Agency (ECHA)* | 0.36–10 $mg/m^3$ | – | [52] |

†Note. *Time-weighted average (TWA) is the average exposure over eight hours.*

**Table 4. Bisphenol-S OELs**

| | Time-Weighted Average (TWA)† Exposure Limit | Workplace Exposure Limit (WEL) | Reference |
|---|---|---|---|
| **United States** *Occupational Safety and Health Administration (OSHA)* | – | – | |
| **Canada** *Canadian Centre for Occupational Health and Safety (CCOHS)* | 3–10 $mg/m^3$ | – | [51] |
| **European Union** *European Chemicals Agency (ECHA)* | 0.36–10 $mg/m^3$ | – | [52] |

†Note. *Time-weighted average (TWA) is the average exposure over eight hours.*

**Types of Workers Most at Risk.**

*Cashiers and retail workers.* Workers handling numerous receipts throughout their shifts [17,38].

*Bank tellers.* Workers that process customer receipts [17].

*Service industry workers.* Waitstaff workers handling customer receipts for payment [17].

**Potential Burden of Injury/Illness.**

Research examining the health effects of BPA and BPS exposure from receipt paper is still under review [22,53]. However, current evidence suggests the following may be correlated:

*Endocrine disruption.* BPA and BPS pose potential impacts on reproductive health (especially for women), metabolism, and development [38,45].

*Increased cancer risk.* Some studies suggest links to breast cancer and prostate cancer, though further evidence is needed [17,40].

*Developmental effects.* Possible links to neurobehavioral problems in children have been discussed, particularly with exposure during pregnancy [18].

***Control***

*Substitution.* Use digital receipts or BPA and BPS-free paper [5].

*Administrative Controls.* Educating workers about proper hand hygiene and minimizing unnecessary contact with thermal papers [40,45].

*Personal Protective Equipment (PPE).* Encouraging the use of gloves when handling receipts for prolonged periods [40,45].

**Disposal**

***Hazard Identification***

*Chemical and Biological Hazards.* Potential exposure to hazardous decomposition products during recycling or incineration processes [8,21].

*Physical Hazards.* Injuries related to waste handling and processing machinery [21].

*Evaluation*

**Level of Risk to Workers.** Workers involved in the disposal of receipt paper may come into contact with chemical substances, especially BPA and BPS [8,21]. Yet, the precise risks associated with throwing away receipt paper are not as thoroughly recorded [22,53].

**Measurement of Risk.**

*Biomonitoring.* The most direct method is measuring BPA and BPS levels in urine or blood samples of waste workers [17,40].

*Workplace Sampling.* Chemical compositions are analyzed in waste products and the environment [8,21].

**Exposure Limits.** Given that it is beyond the scope of this project, the examination of OELs during the disposal phase is not included.

**Types of Workers Most at Risk.** Since receipt paper is non-recyclable, waste workers face potential risks [8,18,21].

**Potential Burden of Injury/Illness.**

*Minor Injuries.* Cuts, scrapes, and bruises are common [24,27].

*Respiratory Issues.* Dust inhalation can lead to allergies, asthma, or other lung problems [25,38].

*Chemical Exposure.* Depending on the substances involved, consequences could range from skin irritation [23,25] to serious long-term health effects [8].

***Control***

*Engineering Controls.* Use enclosed processing systems to contain particulates and emissions [8,21].

*Administrative Controls.* Training on safe handling procedures and emergency procedures [8,21].

*Personal Protective Equipment (PPE).* Provide respiratory protection, gloves, and protective clothing [8].

## V. Discussion

The life cycle and risk assessment of receipt paper revealed multiple occupational hazards, presenting different levels of risk to workers engaged in its various stages. This section will summarize the main findings and measures discussed.

### Key Findings

Following a comprehensive life cycle and risk assessment conducted in this project, the following key findings are presented.

***Environmental Impact and Resource Extraction.*** The production of thermal receipt paper is resource intensive, relying on petroleum-based products and wood pulp.

Manufacturing Hazards. The manufacturing process exposes workers to dangerous chemicals and particulate matter, potentially leading to respiratory issues, skin irritation, and long-term health complications.

***Exposure to BPA and BPS.*** Throughout nearly all stages, both workers and consumers are exposed to BPA and BPS. This exposure is of particular concern for cashiers and retail employees, as these chemicals can disrupt endocrine functions.

***Disposal Concerns.*** Thermal receipt paper is non-recyclable because of its chemical coating, leading to environmental concerns when disposed of in landfills or incinerated.

***Risk Control Measures.*** While certain control measures, including PPE and engineering controls, are currently employed, significant room for improvement remains, particularly in the distribution and usage phases.

***Barriers to Improvement.*** The adoption of safer alternatives and practices is impeded by economic costs, industry opposition, and a general lack of awareness. Given the minimal development in receipt paper technology, policies should aim at phasing them out and encouraging innovation in alternative mediums.

**Takeaway Message**

This life cycle and risk assessment reveals that thermal receipt paper poses a significant risk to workers throughout its entire lifespan. The most concerning aspects are:

***Chemical Exposure.*** Throughout the lifecycle, workers are exposed to harmful chemicals, such as BPA, BPS, and other volatile compounds. This exposure can result in respiratory conditions, skin disorders, and an increased risk of cancer.

***Exposure to BPA and BPS.*** Throughout nearly all stages, both workers and consumers are exposed to BPA and BPS. This exposure is of particular concern for cashiers and retail employees, as these chemicals can disrupt endocrine functions.

***Control Measures***

The current control measures, including PPE and training, seem inadequate to address the widespread health concerns. Here's where improvement is needed:

***Substitution.*** Replace hazardous chemicals with safer alternatives, particularly BPA- and BPS-free paper or digital receipts.

***Engineering Controls.*** Implementing better ventilation systems and enclosed processing units to minimize exposure to dust, fumes, and hazardous chemicals.

***Biomonitoring.*** Regularly monitoring worker exposure levels through blood or urine tests to identify potential health risks early on.

### ***Barriers & Facilitators***

This project identifies the following key barriers and facilitators that impact the handling of risks related to thermal receipt paper:

***Barriers.*** Cost of implementing stricter control measures, lack of awareness about health risks, and resistance to change from industries.

***Facilitators.*** Growing public concern about BPA and BPS, stricter regulations on chemical use, and technological advancements in receipt printing and transaction technologies.

## Conclusion

Overall, the lifecycle of receipt paper presents multiple hazards to workers, with chemical exposures being among the most concerning because of their potential for long-term health effects. While current controls, including substitution, engineering measures, and PPE, are steps in the right direction, gaps in compliance, awareness, and technology present challenges to fully mitigating these risks. Addressing these challenges requires a multifaceted approach involving policy support, technological innovation, and enhanced worker education. The facilitators for improvement include advancements in safer material research, regulatory support for stricter safety standards, and a culture of safety that prioritizes worker health and compliance with protective measures.

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## Appendix

### Homepage

Welcome to my project website! Join me in my exploration of an everyday essential that frequently goes unnoticed: the receipt. No matter the size of the translation, we are accustomed to the saying: "would you like your receipt?" Some choose to keep it, while others opt out, and many simply tuck it away in a junk drawer. Yet, in an age teeming with digital solutions, where we effortlessly pay with a tap from our devices, the paper receipt continues to be the norm. What has even more absurd is that, despite most cash registers automatically printing receipts, whether necessary or not, receipt paper is not recyclable.

Dive right into the following section to explore the (somehow intriguing) world of receipts: [Introduction]

### About

My name is Ben Lipovski and I am a student enrolled in spring 2024 SPPH 381E (Work & Health) at the University of British Columbia. This website results from my examination of the health and occupational hazards associated with receipt paper. Designed using Hugo, a static site generator written in Go, this website uses the Hextra theme to host an engaging and accessible space to share my findings and insights.

This project website is hosted on my personal portfolio. Visit lipovski.ca to explore more about my work and academic endeavours.

For further information on the Hugo framework and the Hextra theme, please consult the following links. [Hugo Website], [Hugo Documentation], [Hextra Repository], [Hextra Documentation].