

CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

Editora chefe

Profª Drª Antonella Carvalho de Oliveira

Editora executiva

Natalia Oliveira

Assistente editorial

Flávia Roberta Barão

Bibliotecária

Janaina Ramos

Projeto gráfico

Bruno Oliveira

Camila Alves de Cremo

Daphynny Pamplona

Luiza Alves Batista

Natália Sandrini de Azevedo

Imagens da capa

iStock

Edição de arte

Luiza Alves Batista

2022 by Atena Editora

Copyright © Atena Editora

Copyright do texto © 2022 Os autores

Copyright da edição © 2022 Atena Editora

Direitos para esta edição cedidos à Atena Editora pelos autores.

Open access publication by Atena Editora



Todo o conteúdo deste livro está licenciado sob uma Licença de Atribuição *Creative Commons*. Atribuição-Não-Comercial-Não-Derivativos 4.0 Internacional (CC BY-NC-ND 4.0).

O conteúdo dos artigos e seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva dos autores, inclusive não representam necessariamente a posição oficial da Atena Editora. Permitido o *download* da obra e o compartilhamento desde que sejam atribuídos créditos aos autores, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

Todos os manuscritos foram previamente submetidos à avaliação cega pelos pares, membros do Conselho Editorial desta Editora, tendo sido aprovados para a publicação com base em critérios de neutralidade e imparcialidade acadêmica.

A Atena Editora é comprometida em garantir a integridade editorial em todas as etapas do processo de publicação, evitando plágio, dados ou resultados fraudulentos e impedindo que interesses financeiros comprometam os padrões éticos da publicação. Situações suspeitas de má conduta científica serão investigadas sob o mais alto padrão de rigor acadêmico e ético.

Conselho Editorial**Ciências Exatas e da Terra e Engenharias**

Prof. Dr. Adélio Alcino Sampaio Castro Machado – Universidade do Porto

Profª Drª Alana Maria Cerqueira de Oliveira – Instituto Federal do Acre

Profª Drª Ana Grasielle Dionísio Corrêa – Universidade Presbiteriana Mackenzie

Profª Drª Ana Paula Florêncio Aires – Universidade de Trás-os-Montes e Alto Douro

Prof. Dr. Carlos Eduardo Sanches de Andrade – Universidade Federal de Goiás

Profª Drª Carmen Lúcia Voigt – Universidade Norte do Paraná



Prof. Dr. Cleiseano Emanuel da Silva Paniagua – Instituto Federal de Educação, Ciência e Tecnologia de Goiás
Prof. Dr. Douglas Gonçalves da Silva – Universidade Estadual do Sudoeste da Bahia
Prof. Dr. Eloi Rufato Junior – Universidade Tecnológica Federal do Paraná
Profª Drª Érica de Melo Azevedo – Instituto Federal do Rio de Janeiro
Prof. Dr. Fabrício Menezes Ramos – Instituto Federal do Pará
Profª Dra. Jéssica Verger Nardeli – Universidade Estadual Paulista Júlio de Mesquita Filho
Prof. Dr. Juliano Bitencourt Campos – Universidade do Extremo Sul Catarinense
Prof. Dr. Juliano Carlo Rufino de Freitas – Universidade Federal de Campina Grande
Profª Drª Luciana do Nascimento Mendes – Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte
Prof. Dr. Marcelo Marques – Universidade Estadual de Maringá
Prof. Dr. Marco Aurélio Kistemann Junior – Universidade Federal de Juiz de Fora
Prof. Dr. Miguel Adriano Inácio – Instituto Nacional de Pesquisas Espaciais
Profª Drª Neiva Maria de Almeida – Universidade Federal da Paraíba
Profª Drª Natiéli Piovesan – Instituto Federal do Rio Grande do Norte
Profª Drª Priscila Tessmer Scaglioni – Universidade Federal de Pelotas
Prof. Dr. Sidney Gonçalo de Lima – Universidade Federal do Piauí
Prof. Dr. Takeshy Tachizawa – Faculdade de Campo Limpo Paulista



Collection: applied environmental and sanitary engineering 2

Diagramação: Camila Alves de Cremo
Correção: Mariane Aparecida Freitas
Indexação: Amanda Kelly da Costa Veiga
Revisão: Os autores
Organizador: Cleiseano Emanuel da Silva Paniagua

Dados Internacionais de Catalogação na Publicação (CIP)

C697 Collection: applied environmental and sanitary engineering 2 / Organizador Cleiseano Emanuel da Silva Paniagua. - Ponta Grossa - PR: Atena, 2022.

Formato: PDF

Requisitos de sistema: Adobe Acrobat Reader

Modo de acesso: World Wide Web

Inclui bibliografia

ISBN 978-65-5983-988-9

DOI: <https://doi.org/10.22533/at.ed.889220305>

1. Environmental and sanitary engineering. I. Paniagua, Cleiseano Emanuel da Silva (Organizador). II. Título.

CDD 628

Elaborado por Bibliotecária Janaina Ramos - CRB-8/9166

Atena Editora
Ponta Grossa - Paraná - Brasil
Telefone: +55 (42) 3323-5493
www.atenaeditora.com.br
contato@atenaeditora.com.br



Atena
Editora
Ano 2022

DECLARAÇÃO DOS AUTORES

Os autores desta obra: 1. Atestam não possuir qualquer interesse comercial que constitua um conflito de interesses em relação ao artigo científico publicado; 2. Declaram que participaram ativamente da construção dos respectivos manuscritos, preferencialmente na: a) Concepção do estudo, e/ou aquisição de dados, e/ou análise e interpretação de dados; b) Elaboração do artigo ou revisão com vistas a tornar o material intelectualmente relevante; c) Aprovação final do manuscrito para submissão.; 3. Certificam que os artigos científicos publicados estão completamente isentos de dados e/ou resultados fraudulentos; 4. Confirmam a citação e a referência correta de todos os dados e de interpretações de dados de outras pesquisas; 5. Reconhecem terem informado todas as fontes de financiamento recebidas para a consecução da pesquisa; 6. Autorizam a edição da obra, que incluem os registros de ficha catalográfica, ISBN, DOI e demais indexadores, projeto visual e criação de capa, diagramação de miolo, assim como lançamento e divulgação da mesma conforme critérios da Atena Editora.



DECLARAÇÃO DA EDITORA

A Atena Editora declara, para os devidos fins de direito, que: 1. A presente publicação constitui apenas transferência temporária dos direitos autorais, direito sobre a publicação, inclusive não constitui responsabilidade solidária na criação dos manuscritos publicados, nos termos previstos na Lei sobre direitos autorais (Lei 9610/98), no art. 184 do Código Penal e no art. 927 do Código Civil; 2. Autoriza e incentiva os autores a assinarem contratos com repositórios institucionais, com fins exclusivos de divulgação da obra, desde que com o devido reconhecimento de autoria e edição e sem qualquer finalidade comercial; 3. Todos os e-book são *open access*, *desta forma* não os comercializa em seu site, sites parceiros, plataformas de *e-commerce*, ou qualquer outro meio virtual ou físico, portanto, está isenta de repasses de direitos autorais aos autores; 4. Todos os membros do conselho editorial são doutores e vinculados a instituições de ensino superior públicas, conforme recomendação da CAPES para obtenção do Qualis livro; 5. Não cede, comercializa ou autoriza a utilização dos nomes e e-mails dos autores, bem como nenhum outro dado dos mesmos, para qualquer finalidade que não o escopo da divulgação desta obra.



PRESENTATION

The e-book: “Collection: Applied Environmental and Sanitary Engineering 2” consists of fifteen chapters that present works that aimed to contribute both to improving the quality and health of the environment and man, as well as to the development of technologies to reduce costs and improve the quality of basic sanitation, remedying and reducing the environmental impacts resulting from human activities.

Waste management in Brazil is “invisible” in the eyes of government plans at the municipal level, which is why precarious sanitation conditions prevail in most municipalities. In view of this, the scientific community has been reiterating through numerous studies, the need to implement systems for the collection and final disposal of waste in an environmentally more correct way.

The basic sanitation system in Brazil has been restructuring itself due to security and information technology that helps to monitor and automate water and sewage treatment systems, the final disposal of waste, the loss of water resources due to failures or ruptures of pipe among others. Added to this, the numerous software that are developed to improve operating systems that can present information in real time and operation in continuous flow, helping operators.

Finally, the study and development of new treatment technologies from agro-industry residues or from new technologies that aim to implement and improve the efficiency of existing conventional processes,

In this perspective, Atena Editora has been working with the aim of stimulating and encouraging researchers from Brazil and other countries to publish their work with a guarantee of quality and excellence in the form of books and book chapters that are available on the Editora’s website and elsewhere. digital platforms with free access.

Cleiseano Emanuel da Silva Paniagua


SUMÁRIO

CAPÍTULO 1..... 1

563 – COMO A GESTÃO DE RESÍDUOS É TRATADA NOS PLANOS DE GOVERNO DOS(AS) CANDIDATOS(AS) À PREFEITOS(AS)

Cristiane Ferreira Pimenta

Henrique Ferreira Ribeiro


 <https://doi.org/10.22533/at.ed.8892203051>

CAPÍTULO 2..... 8

ESTUDO COMPORTAMENTAL DE USINAS DE BENEFICIAMENTO DE RESÍDUOS CLASSE A DA CONSTRUÇÃO E DEMOLIÇÃO

Cristiane Ferreira Pimenta

Henrique F. Ribeiro


 <https://doi.org/10.22533/at.ed.8892203052>

CAPÍTULO 3..... 24

QUANTIFICAÇÃO E COMPOSIÇÃO DOS RESÍDUOS DA CONSTRUÇÃO CIVIL EM ÁREAS DE TRANSBORDO E TRIAGEM

Cristiane Ferreira Pimenta

Henrique F. Ribeiro

 <https://doi.org/10.22533/at.ed.8892203053>

CAPÍTULO 4..... 33

COMPOSTAGEM DE RESÍDUOS ALIMENTARES DO RESTAURANTE UNIVERSITÁRIO DA UNIVERSIDADE FEDERAL DE VIÇOSA

Deysiane Antunes Barroso Damasceno

Marcos Oliveira Dantas

Mônica de Abreu Azevedo


 <https://doi.org/10.22533/at.ed.8892203054>

CAPÍTULO 5..... 44

II-1785 - SETORIZAÇÃO DE UM SISTEMA DE ESGOTAMENTO SANITÁRIO I – DETERMINAÇÃO DAS CARGAS ORGÂNICAS

Moema Felske Leuck

Carlos André Bulhões Mendes

 <https://doi.org/10.22533/at.ed.8892203055>

CAPÍTULO 6..... 65

MANAGEMENT OF FLUORESCENT LAMPS: A CASE STUDY IN THE METROPOLITAN REGION OF RECIFE, PERNAMBUCO, BRAZIL

Eduardo Antonio Maia Lins


Marília Gabriela Jonas de Santana

Andréa Cristina Baltar Barros

Adriane Mendes Vieira Mota

Maria Clara Pestana Calsa

Adriana da Silva Baltar Maia Lins

 <https://doi.org/10.22533/at.ed.8892203056>

CAPÍTULO 7..... 75


ONLINE MONITORING OF THE MUNICIPAL SOLID WASTE COLLECTION SYSTEM

Eduardo Antonio Maia Lins

Roger Ramos Azevedo

Fuad Carlos Zarzar Júnior

Joaquim Teodoro Romão de Oliveira

 <https://doi.org/10.22533/at.ed.8892203057>


CAPÍTULO 8..... 83

IMPLEMENTATION OF IMPROVEMENT ACTIONS IN THE SOLID WASTE MANAGEMENT PROCESS IN SMALL AND MEDIUM CITIES: CASE STUDY OF THE MUNICIPALITY OF PATROCÍNIO LOCATED IN THE STATE OF MINAS GERAIS – BRAZIL

Cleiseano Emanuel da Silva Paniagua

Bruno Elias dos Santos Costa

Valdinei de Oliveira Santos

 <https://doi.org/10.22533/at.ed.8892203058>

CAPÍTULO 9..... 95


A IMPORTÂNCIA DE INVESTIMENTOS EM SEGURANÇA DA INFORMAÇÃO PARA AS OPERADORAS DE SERVIÇO DE SANEAMENTO: UM OLHAR SOB OS INCIDENTES DIVULGADOS

Carlos Henrique Jorge

Dalton Issao Ito

Mariana Espindola de Souza

André Gambier Campos

 <https://doi.org/10.22533/at.ed.8892203059>

CAPÍTULO 10..... 111


AQUACAD-PLUGIN: SIMULAÇÕES HIDRÁULICAS NO AUTOCAD

Luis Henrique Magalhães Costa

Arthur Brito Gomes

Letícia de Vasconcelos Rodrigues

David Ermerson Farias Eugênio


 <https://doi.org/10.22533/at.ed.88922030510>





CAPÍTULO 11 122

AQUACAD: CONVERSÃO ONLINE ENTRE ARQUIVOS DOS PROGRAMAS DA PLATAFORMA CAD, GIS E DOS SIMULADORES EPANET E SWMM

Luis Henrique Magalhães Costa

Guilherme Marques Farias

 <https://doi.org/10.22533/at.ed.88922030511>

CAPÍTULO 12.....	131
APLICAÇÃO DO TANK MODEL NA MODELAGEM DA BACIA HIDROGRÁFICA DO RIO PIRANHAS EM GOIÁS	
Tales Dias Aguiar Débora Pereira da Silva	
 https://doi.org/10.22533/at.ed.88922030512	
CAPÍTULO 13.....	142
UTILIZAÇÃO DE BAMBU “DENDROCALAMUS LATIFLORUS” COMO CAMADA SUPORTE EM FILTRO ANAERÓBIO PARA REMOÇÃO DE DBO E DQO EM TRATAMENTO DE EFLUENTES SANITÁRIO	
Fagner Moreira de Oliveira Adão Genilson Pereira	
 https://doi.org/10.22533/at.ed.88922030513	
CAPÍTULO 14.....	149
DEGRADAÇÃO DE ANTIDEPRESSIVOS RESIDUAIS E CAFEÍNA EM ÁGUA, ESGOTO DOMÉSTICO E LODO DE ESTAÇÃO DE TRATAMENTO EMPREGANDO FOTÓLISE DIRETA	
Ismael Laurindo Costa Junior Adelmo Lowe Plestch Yohandra Reyes Torres	
 https://doi.org/10.22533/at.ed.88922030514	
CAPÍTULO 15.....	167
AVALIAÇÕES ECOTOXICOLÓGICAS DE CONTAMINAÇÕES CAUSADAS POR BIFENILAS POLICLORADAS: UMA REVISÃO	
Rhayane Andrade Junior Rosana Gonçalves Barros Viníciu Fagundes Barbara	
 https://doi.org/10.22533/at.ed.88922030515	
SOBRE O ORGANIZADOR.....	178
ÍNDICE REMISSIVO.....	179

MANAGEMENT OF FLUORESCENT LAMPS: A CASE STUDY IN THE METROPOLITAN REGION OF RECIFE, PERNAMBUCO, BRAZIL

Data de aceite: 01/04/2022

Eduardo Antonio Maia Lins

Federal Institute of Pernambuco - IFPE /
Catholic University of Pernambuco

Marília Gabriela Jonas de Santana

Andréa Cristina Baltar Barros

Adriane Mendes Vieira Mota

Maria Clara Pestana Calsa

Adriana da Silva Baltar Maia Lins

<http://lattes.cnpq.br/9572374845102485>

ABSTRACT: Several companies use fluorescent lamps for the comfort and economy advantages they have, but most do not have a management plan for disposing of these lamps. The objective of this work was to present a management plan for the disposal of fluorescent lamps in a *call center company*, where the 5W2H management tool was used. Information was searched on the disposal of these lamps in four companies, and it was necessary to conduct interviews to know if the procedure used for disposal would follow the standards of the legislation. This is because fluorescent lamps are classified as hazardous waste and cannot be disposed of as common waste. We also researched amounts charged by four organizations located in some cities in the state of Pernambuco, specialized in decontamination and environmentally appropriate disposal of fluorescent lamps. It was observed

that the transportation fee charged by some of these organizations exerted great influence on the costs for referral to appropriate treatment. The amounts charged by these companies ranged from R\$ 1.10 to R\$ 1.80 per unit and may also vary according to the amount of lamps collected. Among the four companies surveyed, three charge transportation fees that vary by distance. It was found that the responsibility for the fulfillment of the reverse logistics of fluorescent lamps by the manufacturers of some brands of lamps is being fulfilled.

KEYWORDS: Waste, Mercury, Impact, Management.

RESUMO: Várias empresas utilizam lâmpadas fluorescentes pelas vantagens de conforto e economia que apresentam, mas a maioria não possui um plano de gestão de descarte dessas lâmpadas. O objetivo do presente trabalho foi apresentar um plano de gestão para descarte de lâmpadas fluorescentes em uma empresa de call center, onde foi utilizado a ferramenta de gestão 5W2H. Realizou-se uma busca de informações sobre o descarte dessas lâmpadas em quatro empresas, sendo necessária para tal a realização de entrevistas para saber se o procedimento utilizado para o descarte seguiria os padrões da legislação. Isso porque as lâmpadas fluorescentes são classificadas como resíduos perigosos e não podem ser descartadas como resíduo comum. Também foram pesquisados valores cobrados por quatro organizações localizadas em algumas cidades do estado de Pernambuco, especializadas em descontaminação e descarte ambientalmente

adequado das lâmpadas fluorescentes. Observou-se que a taxa de transporte cobrada por algumas dessas organizações exerceu grande influência nos custos para o encaminhamento ao tratamento adequado. Os valores cobrados por essas empresas variaram entre R\$ 1,10 e R\$ 1,80 por unidade podendo variar também de acordo com a quantidade de lâmpadas recolhidas. Dentre as quatro empresas pesquisadas, três cobram taxa de transporte que variam de acordo com a distância. Verificou-se que a responsabilidade sobre o cumprimento da logística reversa de lâmpadas fluorescentes por parte dos fabricantes de algumas marcas de lâmpadas está sendo cumprida.

PALAVRAS-CHAVE: Resíduos Perigoso, Mercúrio, Impacto, Gerenciamento.

INTRODUCTION

Hazardous or toxic waste, also called “toxic waste” are those that, when disposed of incorrectly, will cause damage to the environment and living beings in the long term, because their toxins can be released into air, land, and water (MOTA et al, 2011). Such waste usually comes from industries or commerce, but can be residential, agricultural, military, radioactive sources of hospitals, dry cleaners and laundries.

Since the Industrial Revolution, hazardous waste began to have significance, when urbanization increased, due to the population that used to live in the rural area and migrated to the cities, in search of job opportunities, intensifying the generation of more waste (BALBIM, KRAUSE & LINKE, 2016). Among hazardous wastes, mercury appears as a major polluter of the environment, especially if it comes from fluorescent lamps, which represent a significant domestic, commercial and industrial economy, being widely used, without the correct disposal. The fluorescent lamp, when broken, releases the mercury contained inside in the form of vapor that can be inhaled and absorbed in the body, triggering problems to the health of those who handle it or can accumulate in the environment, causing contamination (MORAIS, 2013).

The management of this residue is fundamental for the correct disposal and protection of the environment and the health of living beings. Thus, the process of decontamination of fluorescent lamps of the companies is important, because when the mercury is removed from these lamps, the other components present become recyclable and can be transformed into new materials (MORAES, 2015).

Because it is a hazardous waste, which is often disposed of incorrectly by companies, it was seen the need to research the disposal method that *some call center companies* use for their fluorescent lamps, as well as the cost that this requires.

Studying the disposal management that a specific company was observed that it had no knowledge about the danger of fluorescent lamps that were disposed of improperly. With this, there was a need to create action plans to try to get the resolution of this issue. Creating a management plan for fluorescent lamps used in a *call center company* to reduce environmental impact due to incorrect disposal was the goal of this work.

METHODOLOGY

The call center company here called W was defined as a place of study, located in a building on Avenida Conde da Boa vista nº 150, Recife, Pernambuco, Brazil. The company's building has 12 floors, 11 of them use and responsibility of the company's infrastructure, artificial lighting is used in all work shifts using only fluorescent lamps.

Data collection occurred in a period of 1 year, and the number of lamps in each sector was verified, as well as the frequency of exchanges, depending on the failures presented in the jobs. A questionnaire was conducted with four *other call center companies* to collect information on the procedure for disposing of fluorescent lamps that use and to be able to compare with the procedure of the company W. A study was conducted by four companies that work with decontamination and recycling of fluorescent lamps in the state of Pernambuco and a budget was made on the number of lamps existing in the company W.

The brands of the lamps, the quantity of faulty lamps in each sector, as well as the shape and location that were stored and/or discarded were analyzed. It was also analyzed about the knowledge that the company had about the management of these lamps. It was analyzed that the management of the company's fluorescent lamps, compared with the literature, contained in the current legislations to verify if they were being disposed of correctly.

RESULTS AND DISCUSSION

• **Survey of existing lamps in the company, useful life, and exchange frequency**

The lamps on the operating and administration floors (2,400 units) and the mark of each of them were quantified. The life of the lamps is more than 6,000 h according to the Brazilian Lighting Association (approximately eight months to a year) and their exchange rate is performed only when there are defects, which can take three to six months to accumulate 300 burned lamps.

• **Disposal of fluorescent lamps from other *call center companies***

An e-mail questionnaire was sent to *four call center companies* (A, B, C and D), obtaining a response from only two companies, here called A and B, due to the confidentiality requested. Company A, located about Santo Amaro - Recife – Pernambuco - Brazil, has 5,342 m² and only one *call center operation*, where about 1,700 fluorescent tubular lamps are used for lighting. The exchange frequency is performed immediately when they are defective. The disposal of the lamps was carried out by companies responsible for this type of service in the state of Pernambuco. According to the company's technical responsible, tubular fluorescent lamps (LFT), after the removal of the operation by responsible team, are taken and packed in wooden crate containing a maximum of 300 units, are taken by the

responsible companies. The period to obtain the quantity to fill the crate varies between four and six months.

Company B, located on Av. Dr. Júlio Maranhão – Jaboatão dos Guararapes - PE, has a total area of 36,477 m² and built area of 21,587 m² and only 1 floor of service where about 6,000 fluorescent tubular lamps are used for lighting the environment between the Phillips and Osram brands. The exchange frequency is performed immediately when they are defective. The disposal of Fluorescent Lamps is carried out by a company responsible for this type of service in the state of Pernambuco. According to responsible, the burned lamps are removed and stored in an appropriate place provided by the company responsible for collection, transport, and treatment, where soon after, they are transported in special vehicles to the waste treatment center where they undergo specific treatment.

- **Budget of Companies that work with decontamination and recycle fluorescent lamps**

The recycling company 1, located at Av. Dr. Júlio Maranhão – Jaboatão dos Guararapes - PE, has a total area of 36,477 m² and built area of 21,587 m² and only 1 floor of service where about 6,000 LFT are used for the lighting of the environment between the Brands Phillips and Osram. The exchange frequency is performed immediately when they are defective. The disposal of Fluorescent Lamps is carried out by the company responsible for this type of service. The burned lamps are removed and stored in an appropriate place provided by the company responsible for the collection, transport, and treatment where they are transported in special vehicles to the waste treatment center under specific treatment.

The Recycling Company 2, located in Paulista, Pernambuco, Brazil, has been operating for more than two years in the market of decontamination of fluorescent lamps, from the collection of industrial waste to the final disposal, through the adequacy of materials, physical treatments, chemicals and others. The budget for the decontamination of LF, considering the amount of 300 defective lamps generated every six months by W was R\$ 540.00. The company does not require minimum amount of LF to perform the collection in the contracting company, but charges a transportation fee of R \$ 250.00 off the cost per unit of LF collected, which is R \$ 1.60 per whole LF and R \$ 0.50 per Kg when broken. The treatment is done through special machines for service and supporting up to 600 LF units.

Considering the amount of 300 defective lamps generated every six months by W, the budget would be R\$ 730.00 cost already added to the transportation fee. Comparing the budget of the two companies it was perceived that despite the price charged by Recycling Company 1, per lamp unit is R \$ 0.20 less than recycling company 2 and the price of Kg is R \$ 4.50 cheaper too, since Recycling Company 2 has a lower cost than Recycling Company 1, since there is a charge of R\$ 250.00 to transport the lamps.

The use of fluorescent lamps in homes, industries, shopping centers is highly advantageous in economic terms. From an environmental point of view, due to irregular

disposal, these lamps offer a great risk of impact to the environment due to the mercury contained inside. So what to do with used fluorescent lamps? How and why should they have special treatment at the time of disposal? Rabbit *et al.* (2012) showed that fluorescent lamps have to have special management because of the mercury contained inside, and cannot be treated as common waste. According to Brasil *et al.* (2011), Law 14.236/10 (PERNAMBUCO, 2010) underscores this statement, which states that it is forbidden to dispose of fluorescent lamps in an inappropriate place. Therefore, business managers should note that these issues are of paramount importance when it comes to the health of the environment and, consequently, of human beings as well.

- **5W 2H Tool Action Plans**

In the company W, according to the quantity of burned lamps to be discarded and due to logistics, four actions were created, using the tool 5W2H. In Action 01, information was sent by e-mail to the company’s management and the problem of storage/disposal of burned LF was presented (Table 1).

Tool	Steps	Details
5th W	What, what? (what?)	Introduce the problem of improper storage and disposal of Fluorescent Lamps
	Why is it? (why?)	To generate science among all managers about the risk of contamination by unprotected storage of fluorescent lamps in the warehouse and also the risk of environmental contamination by improper disposal.
	Where, where is it? (where?)	Company W - Recife Branch II
	Who, who? (who?)	Marilia Santana
	When? (when?)	24/02/2021
2:00 p.m.	How is it? (how?)	Send an email to all managers with environmentally legal information about storage and proper disposal of Fluorescent Lamps alerting the risks that their improper disposal may pose to the environment and people.
	How much? (cost)	N/A

Table 1 - Action 01 - Pass information to managers to present storage and disposal problems of fluorescent lamps.

Source: The Authors (2022).

The use of fluorescent lamps in homes, industries, shopping centers is highly advantageous in economic terms. From an environmental point of view, due to irregular disposal, these lamps offer a high risk of impact to the environment due to the mercury contained. So what to do with used fluorescent lamps? How and why should they have special treatment at the time of disposal?

Rabbit *et al.* (2012) showed that fluorescent lamps have to have special management because of the mercury contained inside, and cannot be treated as common waste. Article 57 of Decree No. 23,941 underpins this statement, which states that it is forbidden to dispose of fluorescent lamps in an inappropriate place. Therefore, business managers should note that these issues are of paramount importance when it comes to the health of the environment and, consequently, of human beings as well. In action 02, budgets of some companies providing services around treatment and destination of LF in Pernambuco were presented (Table 2).

Tool	Steps	Details
5th W	What, what? (what?)	Present budget of companies providing services around treatment and destination of LF.
	Why is it? (why?)	For management to analyze all budgets and service proposals to do so, hire what seems best to the reality of the company.
	Where, where is it? (where?)	Company W - Recife Branch II
	Who, who? (who?)	Marília Santana
	When? (when?)	14/03/2021
2:00 p.m.	How is it? (how?)	Send to management via e-mail proposals of budgets of companies that provide treatment service and destination of LF.
	How much? (cost)	N/A

Table 2 - Action 02 - Sending budgets of companies providing services.

Source: The Authors (2022).

In the W company after any proposal that requires money is opened a Purchase Request, where it is analyzed by the company's headquarters and passes 55 per approval process, which can take from 1 to 3 months depending on the urgency and relevance of the purchase. In action 03 it was suggested creation or purchase of boxes to pack the burned lamps while not taken to the destination (Table 3).

Tool	Steps	Details
5th W	What, what? (what?)	Create space to pack burned lamps.
	Why is it? (why?)	The lamps are packed standing without any protection against breaking amid the other objects in a tight tank
	Where, where is it? (where?)	Infrastructure depot
	Who, who? (who?)	Infrastructure employees
	When? (when?)	01/04/2021 to 29/04/2021
2:00 p.m.	How is it? (how?)	Store burned lamps in their own packaging and condition them in cardboard box or drum to temporarily store them.
	How much? (cost)	N/A

Table 3 - Action 03 - Suggestion to create space to pack burned lamps.

Source: The Authors (2021).

Because they store fluorescent lamps in an inappropriate place and without any protection (Figure 2), it was also suggested the purchase of boxes manufactured especially for the packaging of burned tubular fluorescent lamps. Budget research was conducted between two companies (Table 4). Apliquim (2016), also suggests that the storage of lamps is preferably carried out in the original packaging in cardboard boxes and can be accommodated in suitable containers. Just as Zavariz & Glina (1993) said that lamps should be stored in their original boxes and placed in sturdy containers to prevent their breakage.

Enterprise	Box details	Number of boxes needed to store burned 300 LF of the company W	Value per box	Total value
Marzuky - goes in the box	Cardboard box with capacity to pack 80 1.20 lamps (Figure 3)	4 boxes	R\$ 49,50	R\$ 198,00
Mecca smart collection	Container capable of storing 150 lamps (Figure 4)	2 containers	R\$ 942,00	R\$ 1,884.00

Table 4 - Budget of fluorescent lamp packaging boxes companies.

Source: Marzuky (2021).



Figure 2. Fluorescent lamps packed in an inappropriate place.

Source: The Authors (2022).

Note a difference of R\$ 1,686.00 in value between the boxes of the two companies. This difference is because the box of the company Marzuky is made of cardboard and the Mecca is of more resistant material and has activated carbon filter that retains fumes of mercury vapor, in case the lamps break. There are also dotters that prevent shock between the lamps, lock, and footrest to be transported by forklifts.

It was suggested that the company W invest in the purchase of the container box of Mecca Coleta, as it is a more developed equipment for the task of safely storing fluorescent lamps.

Frame 4's action plan for the disposal of the company's fluorescent lamps was suggested. With the hiring of a company specialized in the disposal of hazardous waste that presents a viable budget. The infrastructure sector being responsible for the operational part of withdrawal, storage and contact with the company contracted for the treatment service and final destination environmentally appropriate for fluorescent lamps.

Tool	Steps	Details
5th W	What, what? (what?)	Perform treatment and final disposal of burned lamps
	Why is it? (why?)	Avoid contamination in the environment by chemical components of lamps.
	Where, where is it? (where?)	Lf treatment center and final destination
	Who, who? (who?)	specialized company contracted for the service
	When? (when?)	Semiannually
2:00 p.m.	How is it? (how?)	After a period (3 to 6 months) of storage of lf in a safe place they will be transported by company contracted for treatment and final destination.
	How much? (cost)	R\$ 540.00 per semester

Table 4 - Action 04 - Dispose of Fluorescent Lamps correctly.

Source: The Authors (2022).

The four budgeted companies do the same work of decontamination and recycling of fluorescent lamps. By the processes of crushing and recovery of mercury using the heat treatment mostly. Besides being a legal determination, the correct disposal of fluorescent lamps is a citizen attitude, which aims at environmental well-being and promotes the economy of natural resources, besides avoiding contamination, since it is hazardous waste.

Most of the time, the incorrect disposal of this type of waste occurs because people are unaware of the damage they can cause not only to the environment, but also to themselves. It would be interesting to create campaigns where this information was passed, not only for companies but also for ordinary people who also use fluorescent lamps in their homes and most often dispose of them in ordinary waste.

FINAL CONSIDERATIONS

- Some call center companies that were researched for this work still do not know what to do with their defective fluorescent lamps, and end up performing the disposal improperly, due to the lack of information and supervision of the responsible agencies.
- In relation to the manufacturers of phillips and osram fluorescent lamps, used in the company W, it was observed that they do not comply with the sector agreement, which prevents reverse logistics from being made, proving that they are not taking responsibility for their waste.
- The companies that work with treatment service and destination of fluorescent lamps were able to perform such service, but do not have enough structure to cover the entire State.

REFERENCES

1. APLIQUIM BRAZIL RECYCLE. **Manual of Storage of Fluorescent Wool and containing Mercury**, 2013.
2. BALBIM, R.; KRAUSE, C.; LINKE, C.C., **City and movement: mobility and interactions in urban development**, Brasília: Ipea: ITDP, 2016. 326 p. ISBN: 978-85-7811-284-4.
3. BRAZIL, Y.M.G.M.; SIMÕES, A.S.; ADISSI, P.J.; RODRIGUES, F.R.N., **Analysis of the Reverse Logistics System of Fluorescent Lamps of Public Lighting of South Ceará**, XXXI National Meeting of Production Engineering, Belo Horizonte, MG, Brazil, October 4-7, 2011.
4. COELHO, M.G.; BURJAILI, M.M.; MARAGNO, A.L.F.C.; JUNIOR, M.R.F.; CASTINEIRA, J.L.P.; Mercury Lamps Burned a Solid Residue Causing Environmental Problems, **Journal Environmental Sciences Online**, v.8, n. 1, 2012.
5. MazURKY. <https://www.mazurky.com.br/categoria/caixas-de-papelao-para-descarte-de-lampadas/>. Accessed: 22/01/2021.

6. MECCA. **Products developed by Meca Coleta Inteligente**, Curitiba, PR, 2021.
7. MORAIS, A. S.C. **Incorporation of Fluorescent Lamp Glass Residue in Red Ceramic**, Doctoral Thesis, Science and Technology Center of the State University of Norte Fluminense, 2013.
8. MORAES, V.M. **Fluorescent Lamp Residues: Its Context in PNRS and the Importance of Proper Destination**, Undergraduate Monograph, Federal University of Rio de Janeiro, Rio de Janeiro, RJ, 2015, 57 p.
9. MOTA, J.C.; ALMEIDA, M.M.; ALENCAR, V.C.; CURI, W. F. **Environmental Characteristics and Impacts Caused by Solid Waste: a Conceptual View**. I International Congress of The Underground Environment, September 15-18, 2009, São Paulo, SP.
10. PERNAMBUCO, **Law No. 14. 236, of December 13, 2010**. It provides for the State Solid Waste Policy, and provides other measures.
11. ZAVARIZ, C.; GLINA, D.M.R.; Effects of Occupational Exposure to Mercury on Workers of an Electric Lamps Industry Located in Santo Amaro, São Paulo, Brazil, **Cad. Saúde Públ.**, Rio de Janeiro, 9 (2): 117-129, Apr/Jun, 1993

ÍNDICE REMISSIVO

A

Ação antrópica 147

Água 2, 36, 37, 41, 44, 46, 47, 48, 49, 50, 52, 53, 54, 59, 60, 61, 62, 63, 64, 96, 98, 99, 100, 101, 102, 103, 104, 105, 107, 111, 112, 113, 121, 122, 123, 127, 128, 129, 130, 132, 133, 136, 137, 149, 152, 153, 157, 158, 159, 160, 161, 162, 168, 170, 171, 174

Águas superficiais 46, 54, 55, 56, 57, 58, 59, 60, 61, 62, 64, 149, 150, 151, 161, 163, 170, 172

Antidepressivos 149, 151, 152, 154, 155, 159, 163

Áreas de Transbordo e Triagem (ATT) 24, 25, 26, 27, 31, 32

B

Bacias hidrográficas 47, 63, 123, 131, 140, 141

Back-end 124

Bambu 142, 143, 144, 145, 147

Bifenilas policloradas (PCBs) 167, 176, 177

Bioensaios 167, 174

Biofilme 142, 144, 145, 147

Biota 86, 149, 150, 176

C

Collection 24, 44, 45, 67, 68, 71, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94

Compostagem 3, 19, 20, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43

Conselho Estadual de Política Ambiental e Recursos Hídricos (COPAM/CERH) 147

Construção civil 4, 10, 11, 12, 14, 15, 17, 20, 22, 23, 24, 25, 27, 28, 31, 32

D

Demanda Química de Oxigênio (DQO) 143, 147

E

Ecotoxicologia 167, 169, 175, 176

Estação de Tratamento de Esgoto (ETE) 142, 143, 147

F

Fármacos 149, 150, 151, 152, 155, 156, 158, 160

Filtro anaeróbio 142, 143

Fluorescent lamps 65, 66, 67, 68, 69, 70, 71, 72, 73

Fotólise 149, 151, 153, 154, 156, 157, 158, 160, 161, 162, 163

Fototransformação 149

Front-end 124

G

Garbage 75, 77, 78, 79, 80, 81, 82, 83, 84, 86, 88, 89, 91, 92

Gestão de resíduos 1, 2, 3, 4, 7

Gradiente reduzido generalizado 131, 133, 136

H

Hazardous 65, 66, 72, 73

I

Impactos ambientais 8, 17, 34, 107, 142, 150, 174

Impactos sistêmicos 167

L

Landfills 83, 84, 86, 92, 94

Linguagem de estilo - CSS 124

Linguagem de marcação - HTML 124

M

Meio ambiente 8, 23, 27, 28, 32, 34, 41, 61, 75, 95, 96, 141, 142, 149, 154, 168, 176

Microcontaminantes 149, 151, 157, 163

Modelos hidrológicos 131, 132

Model-View-Controller (MVC) 124

Municipal Solid Waste (USC) 75, 76, 77, 82

O

OnLine Management 75

Organismo-teste 167

P

Patógenos 33

Plano de governo 1, 2, 4

Política Nacional de Resíduos Sólidos (PNRS) 34, 41

Poluentes emergentes 149, 150

Poluentes Orgânicos Persistentes (POPs) 167, 168, 176

Problemáticas ambientais 1, 2

Produtos farmacêuticos 149

R

Radiação solar 135, 149, 151, 153, 162, 163

Reciclagem 3, 8, 9, 10, 11, 12, 14, 15, 16, 17, 20, 23, 24, 25, 26, 27, 29, 31, 34, 172

Recursos hídricos 41, 44, 61, 122, 130, 131, 132, 137, 141, 142, 147

Recursos naturais 9, 61

Resíduos alimentares 33, 35, 40

Resíduos da construção e demolição 1, 8, 9, 10, 11, 17, 18, 23, 24, 25, 26, 27

Resíduos orgânicos 33, 34, 35, 42, 43

S

Saneamento básico 2, 7, 60, 63, 64

Segurança cibernética 95, 97, 98, 99, 100, 101, 104, 105, 106, 107

Selective collect 83

Simulador hidráulico 111

Sistema de abastecimento de água 104, 111, 112, 127

Sistema de Esgotamento Sanitário (SES) 44, 46, 59

Softwares 48, 75, 103, 112, 122, 123

T

Tank model 131, 132, 133, 135, 136, 137, 138, 139, 140, 141

Tecnologia da informação 95, 97, 98, 99

Tecnologia operacional 95

Teste de germinação 33, 35, 36

Trucks 75, 76, 78, 79, 81

U


United States Environmental Protection Agency (USEPA) 106, 109


V


Variáveis ambientais 131


W

Water resources 83, 92, 131

 www.atenaeditora.com.br


 contato@atenaeditora.com.br


 [@atenaeditora](https://www.instagram.com/atenaeditora)


 www.facebook.com/atenaeditora.com.br


Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

 www.atenaeditora.com.br

 contato@atenaeditora.com.br

 [@atenaeditora](https://www.instagram.com/atenaeditora)

 www.facebook.com/atenaeditora.com.br

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**