Young Logistics Professionals Award 2022

Resilient Solutions: The Future of Freight Forwarding and Logistics

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ABSTRACT

More than ever, the role of the logistics specialists in the world's economy has been highlighted as part of the critical infrastructure driving world trade. Moving goods from one country to another can be very complex. Logistics specialists are responsible of keeping the supply chain flowing internationally. This dissertation aims to bring to light the challenges that the freight forwarders must overcome to successfully deliver goods to the right place, at the right time, and in the right condition. In addition, this paper provides insights on the resiliency of the supply chain with a focus on sustainability. The transportation of two key products for the Canadian economy will be illustrated, where I use analytical tools to determine the best routings taking into consideration: transit time, cost, and CO_2 emissions. By exploring more than one alternative to deliver the goods, we can present viable options to the client. The ultimate choice of routing is based on client needs and priorities. The importation project focuses on over dimensional generator engines moving from Germany to Northern Ontario, Canada. The generator engines are needed for an expansion project in the mining industry. In contrast, the export project showcases a dangerous goods product moving from Canada to Peru. Originally the goods were to be transported via ocean, but due to its urgent need had to shift to air mode of transportation. Both projects are unique, illustrating the challenges and key factors of decision making in the freight forwarding and logistics industry. One of my main goals is to encourage the industry to work together to build a more resilient supply chain and sustainable future.

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List of Abbreviations

CBSA: Canada Border Services Agency

CERS: Canadian Export Reporting System

DAP: Delivered at Place

DG: Dangerous Goods

FAS: Free Alongside Ship

FF: Freight Forwarder

GDP: Canada's real Gross Domestic Product

GGM: Greenstone Gold Mine

HBL: House Bill of Lading

ICC: Institute Cargo Clauses

LTD QTY: Limited Quantities

MBL: Master Bill of Lading

MSDS: Material Safety Data Sheet

NOTOC: Notification to Captain

POD: Port of discharge

PG: Packing Group

RUC: "Registro Único del Contribuyente"

UN-number: United Nations number

SDR: Special Drawing Rights

INTRODUCTION

The global supply chain has been heavily impacted due to recent worldwide crises faced since the COVID-19 pandemic. “Reliability, in terms of transit and frequency, is at an all-time low, impacting predictability and making any planning extremely difficult. Without planning certainty, managing the supply chain has become mission impossible” (FIATA-REVIEW #138, 2021). Despite the challenges, the crisis also represents a great opportunity to rebuild a better, more sustainable, and resilient supply chain. Freight forwarders play a critical role as the “architects of trade” to provide customized sustainable solutions considering cost, speed, and reliability (Graber, 2021).

This dissertation illustrates the different needs and unique transportation challenges of two different key products for the Canadian economy. The first project describes an importation movement of oversized diesel generators from Germany to Canada. The selection of the best port of discharge, the transit time, cost, and use of multimodal transportation were crucial for the successful execution of this movement. The second project showcases the complexity of the transportation of dangerous goods from Canada to Peru. The due diligence when shifting dangerous goods from ocean to air is emphasized.

In both projects, I have highlighted sustainability as part of my decision making. In order to ensure our planet thrives for future generations, it is very important to place sustainability as one of our top priorities.

IMPORTATION PROJECT

Mining is a main economic activity in Canada and one of the primary minerals obtained is gold. This activity contributed by a total of around CAD $34.6 billion to Canada's real Gross Domestic Product (GDP) in 2020 (Statista, 2022). In fact, Canada is one of the top five gold producing countries in the world (GoldHub, 2021). The province of Ontario is the top gold producer, contributing 42.1% of total production. For the extraction, processing and transportation of this metal, a huge amount of power is required to operate heavy duty machinery in remote areas. Therefore, the mining industry depends greatly on generator engines to fulfill its power needs (Natural Resources Canada, 2021).

In the event that a mine requires renewing or expanding their power capacity, the freight forwarder (FF), plays a crucial role in sourcing solutions to ensure a customer's success. The successful achievement of any transportation project is rooted in a well-executed plan and teamwork.

The Greenstone Gold Mine (GGM) company in Geraldton, Ontario reached out to me to collaborate, as logistics specialist, on their expansion project. The engineers from GGM needed to purchase 7 large Generator Engines from Caterpillar Company in Rostock, Germany. The generators are needed to fulfill the required power supply of 2,716 kW. The dimensions of the model requested are L 14.25x W 3.30x H 4.61 meters and weighing 165 metric tons (MT) each.

Greenstone Gold Mine

This mine is in the Municipality of Greenstone, in Northern Ontario. Located at the intersection of Provincial Highway 584 and Trans-Canada Highway 11, the mine is approximately 4 kilometers south of the town of Geraldton, ON (Appendix-A). It is

around 275 km northeast of the city of Thunder Bay, ON and 805 km northwest from Sudbury, ON (Greenstone Goldmines, 2022).

Objective

To propose the most viable, sustainable, and cost-effective solution to bring the generator engines from the Caterpillar plant in Rostock, Germany to the GGM company in Geraldton, Ontario. Transportation will be arranged under FAS, Rostock Port, Germany Incoterms® 2020 to fulfill the power supply requirement for their expansion project.

Transportation Analysis

Since the destination of the generators is in Ontario, it should be noted that these pieces are considered “superloads” from the Ministry of Transportation, because each load exceeds 120,000 kg gross vehicle weight. Furthermore, the vehicle and load maximum permitted height is 4.15 m (MTO, 2021). A superload like this must be transported by rail to the closest possible siding of the delivery site. The nearest rail siding to the mine is Longlac, ON, which is 40 km away, but it doesn’t have any public track for unloading railcars. There is however a public unloading facility in Sudbury, ON around 805 km away, but we wouldn’t be able to deliver those goods from there according to engineering structure reviews and route surveys.

For the reasons stated above, I proposed to my client to purchase 10 smaller generators units of Model-2 from the same supplier. Both models were analyzed with intense detail from an engineering and logistical perspective. In Table-1, a comparison of the two considered generators engines for this expansion project is presented.

Table-1. Generator engines comparison

Generator Engine	Model-1	Model-2
Dimensions (m)	L 14.25 x W 3.30 x H 4.61	L 9.00 x W 2.80 x H 3.00
Weight (each)	165 MT	60 MT
Volume (each)	216.79 CBM	75.60 CBM
Value FAS (each)	US$ 750,000.00	US$ 200,000.00
Units needed	7	10
Max. power	388 kW x 7 = **2,716 kW**	298 kW x 10 = **2,980 kW**
Total FAS Cost	USD $ 5,250,000.00	USD $ 2,000,000.00

My proposal has the advantage of satisfying the power needed onsite, using 10 units versus 7. In addition, several viable transportation routes can be evaluated for its delivery. As a result, my client decided to purchase the Model-2 generators for the project.

ROUTE AND COST ANALYSIS

All transportation routes must be firstly analyzed from a delivery point of view. If details are not carefully reviewed when plans are being made for project cargo, even the best-laid plans can fall apart (CIFFA, 2014). To be able to propose different routings I must have the following crucial information:

- Shipping Drawing of the Cargo-indicating the center of gravity, lifting, and lashing points marked on the cargo (Appendix-B)
- Road weight and dimensions restrictions by provinces
- Seasonal operating window of the ports
- Readiness of the freight

Canadian East Side Ports

Various ports of discharge (POD) in Canada were considered to evaluate price, transit time, and routing. Ontario has more than 250,000 lakes, which in large part constitute the Great Lakes, at higher altitude than the Atlantic Ocean (Hillmer & Bothwell, 2020). The St. Lawrence Seaway, with a total of 15 locks, was constructed to permit oceangoing vessels to access that area (Appendix-C). The shipping window for discharging in the Great Lakes ports, such as Thunder Bay and Hamilton, is open from the end of March until late December. During the winter months, the lakes freeze, and ships cannot transit. In contrast, the St. Lawrence ports such as Montreal, Bécancour, Sorel, among others, are open year-round (The St. Lawrence Seaway, 2020). In addition, on the Atlantic Ocean there are other ports such as Halifax and St. John that operate year-round.

The closest POD to Geraldton mine is Thunder Bay, in Lake Superior. However, ships typically prefer not to call the upper lakes because of the high costs of pilotage, and many choose to stop in another port.

Caterpillar Company

The Caterpillar plant in Rostock has its own sea quay loading facility with heavy lift cranes at the dock site, approximately, 1 km away from Rostock Port (Appendix-E). Since the freight will be crossing the Atlantic Ocean, I contacted Spliethoff and BBC carriers that have geared vessels and can take this type of cargo. The Caterpillar's berth has some 5 m draft about maximum length overall of 100 m, so it is not possible for those carriers to load at the shipper's quay.

Terms of sale

The seller and the buyer agreed on the purchasing term “Free Alongside Ship” FAS, Rostock Port, Germany Incoterms® 2020. This applies for break bulk cargo transported via ocean (CIFFA, 2016). The seller complies when the goods are placed alongside the ship at the named port of shipment and customs cleared for export. The buyer bears all cost and risk for the goods beyond this point.

Sustainability

Due to CO_2 emissions of the transportation of goods it is important to provide alternatives to take care of the environment, where the logistics industry plays an important role. For this project, I provided my client a CO_2 footprint report of the total emissions for each routing, which I obtained using the EcoTransIT platform and methodology (Appendix-H). The main leg of this transportation project is via ocean, this mode of transportation presents the smallest carbon footprint from all modes of transportation. In contrast, for the inland transportation portion there is 5 times less CO_2 emissions by rail than by truck (Greatlakes-seaway, 2021).

Routing options

With the advice from several expert carriers and taking into consideration the previous analysis, the most suitable routing options are compiled in Table 2.

Table-2. Routes and cost comparison

Option	Routing	Cost (USD $)	CO_2 emissions (TONS)	Transit Time (Days)
1	Port of Rostock (BBC – ocean) → Port of Thunder Bay → GGM (Road)	1,562,927.00	81	40
2	Port of Rostock (Spliethoff – ocean)→ Port of Hamilton → GGM (Road)	905,791.00	140	45
3	Port of Rostock (Spliethoff – ocean) → Port of Bécancour → Sudbury Rail Siding (CN – rail) → GGM (Road)	964,465.00	94	37
4	Port of Rostock (BBC – ocean)→ Port of Halifax → Sudbury Rail Siding (CN – rail) → GGM (Road)	1,009,563.00	109	39

Please refer to Appendix-J for detailed routings and cost analysis.

Route evaluation by statistical analysis

The use of statistical tools helps us analyze data to evaluate information in a quantitative way to make the most suitable decisions. As freight forwarders, we can use these tools to provide our clients with best-fit solutions, by evaluating the strengths and limitations for each scenario. Given the objective to narrow down the different options to move this freight, I applied a statistical method of decision-making described in Appendix-K. The factors that were considered for this method and their relevance are the cost (50%), CO_2 emissions (30%), and transit time (20%). The relevance (%) was assigned in agreement with the importance of these factors to my client.

The two routes with the highest score from the statistical analysis were the option-3 via Bécancour with a value of 33 and the option-4 via Halifax with a value of 27. Those options include an intermodal combination of rail/truck delivery. In fact, rail is a sustainable and environment-friendly alternative to deliver freight, faster than via ocean and pollutes less than via truck (FIATA-REVIEW #139, 2021).

To choose the best option among the top scores from the statistical analysis, port competitiveness reports and expert carriers' opinions were also taken into consideration. Below I have outlined the main advantages and disadvantages.

OPTION-3 VIA BÉCANCOUR

Advantages

- Faster transit time
- Economical option
- The second option with lower CO_2 emissions
- Direct discharge from vessel to rail

Disadvantages

- 6% more expensive than the cheapest option

OPTION-4 VIA HALIFAX

Advantages

- Closer to Europe than any other east coast port of call
- Good rail access

Disadvantages

- Higher CO_2 emissions
- Longer inland transit time
- More expensive than option-3 and 2

From the above options, I recommended option-3 to my client because it offers a lower price, lower CO_2 emissions, and faster transit time than option-4. In addition, it involves less risk than other options provided.

EXECUTION PLAN

In this section, I have described all stages of the intermodal movement for the selected route to ensure the successful delivery of the freight, with the most efficient and safety handling processes for each transportation leg.

The executed transportation plan occurred between June 17th and July 23rd. The timeframe was selected to avoid the wintertime when the train runs slower, and the spring thaw restrictions in effect from March until May in Northern Ontario (511on, 2021).

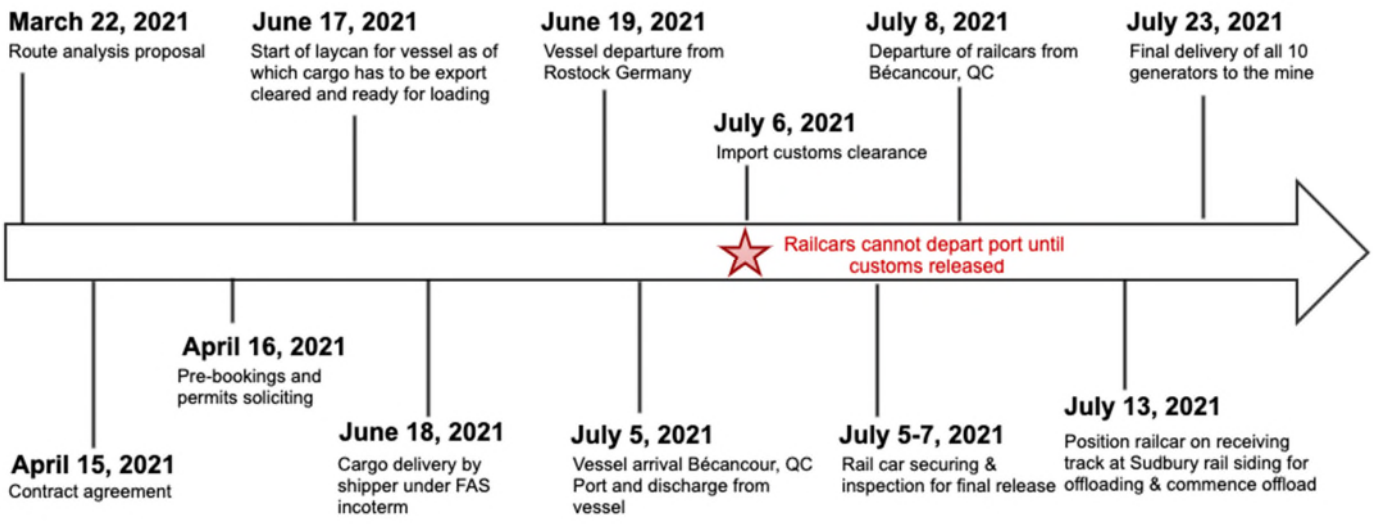

Figure-1. *Import shipment timeline*

Rostock Port

- **Pre-arrangements**

I requested the supplier to notify readiness of the engines at least 8 weeks in advance to make all the necessary arrangements. This route was quoted as a Full Liner rate stowed under-deck to prevent damages. As on-deck cargo is at greater risk of water damage, loss overboard, and frost.

Documentation to be provided by the supplier:

- Commercial Invoice with the declared value of the goods, HS code and country of origin
- Packing List
- Customs Export Declaration
- CSA certificate

It is the shipper's responsibility to customs clear the goods prior delivery to nominated loading terminal alongside the Spliethoff vessel. They must provide the export declaration from the e-customs system "ATLAS", which provides the Movement Reference Number to export the goods.

- **Shipping process**

The freight was placed underhook of the Spliethoff vessel as per required loading sequence at Rostock. DSV office in Germany assigned a shipment number in the system for tracking and tracing.

The below information was required to generate the Master Bill of Lading (MBL) and House Bill of Lading (HBL).

Table-3. Information required for the BLs

Information	MBL	HBL
Description of goods	Generator Engines HS Code: 8502.12.00.00	
Freight quantity	**Weight** (600,000 kgs) **Volume** (756 CBM) / **Pieces** (10)	
Place of Receipt	Rostock	
Port of Loading	Rostock	
Port of Discharge	Bécancour	
Place of Delivery	Bécancour	
Shipper's name and address	DSV Germany	Caterpillar Motoren Rostock GmbH
Consignee's name and address	DSV Canada	Greenstone Gold Mine
Notify party's name and address	Same as consignee	
Vessel name and voyage number	MV FORTUNAGRACHT V: 1223	
Document type	Seaway bill	Express HBL

The MBL was issued by Spliethoff, which is the carrier, and the HBL was generated by DSV Germany.

The shipper used a metal skid with adequate lifting points to mount each generator and tarp them properly. At the port, the carrier loaded the engines with their geared cranes of the vessel (Appendix-M). The Fortunagracht is a general cargo vessel built in 2012. It is currently sailing under the flag of Netherlands. Its gross tonnage is 8,620 TONS, and its length is 136.64 m. It has in total 3 starboard side cranes which are designed to handle heavy cargo. Once on board, the engines were professionally stowed and lashed to prevent shifting.

Bécancour Port

- **Pre-arrangements**

To request a railcar for dimensional cargo, it is necessary to complete a rail clearance form (page 52, CIFFA 2016). Engineering transportation drawings need to be submitted to the railway. Then, a preliminary clearance file is issued and used to send a formal railcar reservation. A minimum of 8-10 weeks advance notification is required to ensure all equipment, approvals and permits were ready to meet the shipping schedule. Western Dimensional, which was the selected inland transport service provider, was notified with proper notice to set everything up accordingly. Nevertheless, a contingency plan to mitigate the risk of not having the sufficient railcars available at the time of arrival was considered. The freight would be moved to a storage place (underhook to place-of-rest) to avoid incurring vessel demurrage/detention charges, which are very costly.

- **Shipping process**

The ocean transit time from Rostock to Bécancour was 16 days. At its arrival, the freight was directly discharged from the vessel to the shipside rail located at the section B-4 of the pier (Appendix-I). One generator was loaded per 4-axle heavy-duty flatcar TTX, that has a load capacity of 245,000 LBS and a low deck of 38’ (Appendix-D). They were properly lashed, secured, and inspected before its departure.

Import Customs Clearance

When importing goods into Canada by ocean, the Canada Border Services Agency (CBSA) requires submitting the Advanced Cargo Information also known as

e-Manifest, which indicates the cargo, conveyance, and Cargo Control Number, at least 24 hours prior the cargo was loaded into the vessel at Rostock Port (CIFFA, 2016).

The arrival notice was received once the vessel entered Canadian water. I ensured that the broker had the required documentation to submit the B3-Canada Customs Coding Form to the CBSA, because the railcars cannot depart until customs released. The customs clearance was done in relation to Port 0322, sublocation code 2308.

The generators with HS code 8502.12.00.00 are duty free as per the Canadian-European Union Tariff (CEUT). There was no special requirement other than CSA approval for its importation.

Sudbury Rail Siding

This is the last transportation leg; the rail siding is approximately 805 kilometers from the mine.

- **Pre-arrangements**

  These generators are considered out-of-gauge and to move them from Sudbury we required the city of Sudbury and Ministry of Transportation (MTO) permit since were only moving in the province of Ontario (Appendix-F). Western Dimensional obtained the permits within 5 days.

- **Shipping process**

Once the generators arrived in Sudbury, five trailers were onsite for the last leg of the journey. A gantry crane was used to offload the pieces from the railcars. One

generator per trailer type configuration 13-axle removable gooseneck float (Appendix-G) was loaded, which can carry up to 250,000 lbs. The gooseneck detachments help to simplify loading/unloading heavy equipment using a vertical ramp. Two trips per trailer were completed at an average speed of 40 to 50 km/h during daylight hours. This movement took ten days and was set up as free on truck with the required private escorts. Upon arrival to the mine, the generators were unloaded using cranes and properly stored.

RISK ANALYSIS

The below risks and countermeasures were identified after a careful analysis of the challenges that could arise along the journey.

Table-4. Risks and counteractions

Risk	Counteraction
Damages or loss of the cargo	Proposed the client to purchase Marine All Risk Cargo Insurance
Vessel detention charges	Gave advanced notice to the inland carrier to have the railcars ready at time of vessel discharge
Weather restrictions	Avoid having shipped the equipment when the spring thaw restrictions are in place. Moreover, avoided the wintertime when the trains run slower
Customs hold that could cause delay	Arranged pre-clearance of the cargo. Ensured that all the documentation was provided to the customs broker on time

INSURANCE

All the movements and handling of the cargo have been made by certified professionals. That said, there are always risks that we cannot anticipate (Appendix-N). The liability of the FF as a NVOCC according to the Hague-Visby Rules is limited to 2 Special Drawing Rights (SDR)/kg of the gross weight of the goods lost or damaged, whichever is higher (Tong-jiang & Peng, 2009). The consignee will not recover the total amount of the value of the goods if something happens of this high value shipment. As such, I recommended my client to purchase additional All Risk Cargo Insurance under Institute Cargo Clauses (ICC) “A” terms paying a premium of USD $0.35 per USD $100 value, to be fully indemnified in the event of damage or loss of the cargo.

Goods Value (USD)	+	Freight Value (USD)	+	10%	=	Insurance Value (USD)
$2,000,000.00		$964,465.00		$296,446.50		$3,260,911.50

Insurance Value (USD)	x	Selling Rate %	=	Insurance Sell (USD)
$3,260,911.50		0.35		$11,413.19

JOB COSTING

PRICING Option-3 Carrier- Spliethoff - Bécancour		
Description of Charges		**USD**
Freight charges:		
Project handling fee		558.00
Ocean freight (Full Liner Terms)		489,500.00
Destination charges:		
Port charges		
Under hook to direct railcar / to place-of-rest*		20,405.00
Place-of-rest to truck or railcar		19,899.00
Wharfage		1,716.00
Terminal charge (including 30 days of outside storage)		1,410.00
Labour for lashing and securing (8-hour call) 2 gangs		3,512.00
Delivery charges		
Rail Transport-Port of Bécancour, QC to Sudbury, ON rail siding		235,578.00
Mobilization for all manpower and labour		35,433.00
Road delivery-Sudbury, ON rail siding to Greenstone Gold Mine		156,204.00
COVID-19 Surcharge		250.00
Additional charges below:		
Materials for lashing and securing, welders and consumables: Cost + 35 %		
Demurrage/Damages for detention USD 30,000.00 - day or pro rata		
Additional outside storage: $0.54 per m3 per 7-day period or part		
Rate includes 2 private escorts for the delivery		
4 hours to load and unload, $255.00 per hour beyond free time		
*To be billed as applicable		
TOTAL	**$**	**964,465.00**
All Risk Cargo Insurance	**$**	**11,413.19**

SUMMARY

The Greenstone Gold Mine's expansion project was successfully concluded. The alternative of purchasing the generators Model-2 was an excellent enhancement for the benefit of my client to fulfill their power supply needs.

Several Canadian East Coast discharge ports were considered and analyzed to deliver the 10 generators. The best proposed route with a combination of ocean-rail-truck (Rostock-Bécancour-Sudbury-GGM) was selected using a statistical analysis considering cost, sustainability, and transit time. Moreover, the analysis encompassed consultation of competitive reports and expert advice to identify the main advantages and lower risks. Therefore, I strongly recommend that customers and logistics professionals work together in collaboration to achieve great results.

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EXPORTATION PROJECT

The world has been fighting the COVID-19 outbreak for more than one and a half years, but that has not been the only health issues that the world is currently facing. Mosquito-borne diseases like dengue, malaria and zika affect every year approximately 700 million people (Mou, et al., 2022). Symptoms of the Coronavirus are like the dengue, which can lead to misdiagnosis and can cause severe health problems. Mosquitoes can be found almost year-round in humid tropical region countries like Peru in South America (Appendix-R). In January 2021, while the third wave of COVID-19 hit, Peru was still battling the dengue epidemic that has been difficult to control (OCHA, 2021).

The pesticide manufacturing industry contributed CAD $124 million to the 2021 Canadian GDP (CIS, 2022). Among pesticides, there is a classification of insecticides, which are products designed specifically used for killing insects such as mosquitoes. Insecticides are considered dangerous goods (DG), which are products that pose a risk to health, safety, or the environment if are not properly controlled (UNECE, 2015). Freight Forwarders must be certified agents to be able to handle DG goods complying with the global regulations. Nevertheless, DG cargo always present a higher level of difficulty to be transported.

The manufacturer Insectron Inc. based in Newmarket, Ontario reached out to me to urgently export their Dangerous Goods freight via air to Peru. They normally ship their products via ocean, but their client immediately requires more insecticide to replenish their stock to control mosquito population.

Objective

To urgently ship via air liquid insecticide from the manufacturer Insectron Inc. in Canada to a distributor in Peru. The product is DG cargo according to the transport information section (Appendix-V) of the Material Safety Data Sheet (MSDS). The terms of sale were DAP, Exterminex Warehouse Horacio Cachay Diaz, La Victoria 15034, Peru Incoterms® 2020.

Transportation Analysis

The transit time by ocean from Toronto to Lima can take from 20 to 35 days. However, there have been extensive delays due to port congestions, increased blank sailings, container shortages all compounded by the COVID-19 pandemic. Because the consignee was running out of stock inventory of this product, the shipper requested to urgently ship one of their lots via air. As the airfreight industry has also been impacted by the pandemic situation, the flights frequency is reduced, and prices increased. Nevertheless, the transit time by air is faster from Toronto to Lima compared to ocean.

DG Cargo Considerations

There are various responsibilities shared among the parties handling the DG, such as the shipper, FF and carrier. The shipper is responsible to classify, identify, pack, mark, label, placard and provide the correct commercial documentation. Whereas the FF is responsible to verify that the documentation and goods comply with the requirements to be transported. The carrier is responsible to determine if the goods can be accepted for transportation.

Since the larger part of the responsibility relies on the shipper and sometimes their personnel are not fully trained on DG handling, consultant firms are available to be hired by the shippers to comply with the regulations. Consultants instruct the shipper how to pack their products and guide them on how to fill the documentation. It is necessary that the shipper provides the signed DG Declaration to the FF. The reason being, is if an incident occurs during its voyage and the declaration was not signed by the shipper, the FF will automatically be held responsible/liable for any consequences.

I had to ensure that the shipment complied with the DG regulations as per the IATA DG book. The hazardous materials are identified by the United Nations under four-digit numbers (UN-number). My client's product classification lies under UN1993, which can be found in the IATA book page 293 (Appendix-T). This UN-number has a star sign next to it (★), which means that next to the proper shipping name, the technical name or chemical group name(s) in parentheses needs to be included.

Packaging and labeling

The regulations determine depending on the UN-number and packing group (PG) how to pack the goods for their transportation. If limited quantities (LTD QTY) are permitted for the article or substance, the maximum net quantity allowable per outer package can be found in the column H of the section 4 of the IATA Dangerous Goods List. In that section, can also be identified if the goods can be transported on Passenger and Cargo Aircraft, Cargo Aircraft Only or forbidden to be shipped by air.

There are 9 classes of dangerous goods. The class that my client's shipment pertains to is the number 3 which are the flammable liquids. From that class number

there are three PG. The “PG I” applies for the substances that present a high degree of danger during transportation. Whereas the “PG II” presents a medium degree of danger and “PG III” a minor degree of danger during transportation. The “PG III” maximum LTD QTY allowable per outer package via air is 10 L for UN1993. The inner packing instructions that needed to be met according to column G are Y344 (Appendix-Q). It indicates that the NET quantity per inner packing is 5 L as LTD QTY. The outer package of my client was a box that contains 6 inner plastic bottles of 0.5 L; therefore, it complies with the regulation to be shipped as LTD QTY.

Route evaluation by statistical analysis

I contacted various carriers, that transport to Peru to identify the best routing option based on cost, CO_2 emissions, and transit time (Table-5). I ensured that all state and operator variations were complied with section 2.8 of the IATA DG book.

Table-5. Routes and cost analysis

Option	Code	ID	Airline	Routing	Cost (USD $)	CO_2 emissions (TONS)	Transit Time YYZ-LIM (Hours)
1	AC	014	Air Canada	YYZ → MIA→ LIM	7,392.20	6.83	12
2	KL	074	KLM Cargo	YYZ → AMS → LIM	9,751.40	16.70	49
3	BA	125	British Airways	YYZ → LHR → MAD → LIM	8,265.70	17.40	120
4	AV	134	Avianca Cargo	YYZ → MIA → LIM	7,150.50	4.81	102

To determine which would be the best route to propose to my client based on a quantitative approach, I used the same statistical method described in Appendix-K. Because this shipment was needed urgently at destination, the relevance of the transit time was given the higher percentage (50%), then the CO_2 emissions (30%) and lastly the cost (20%). The relevance (%) was assigned in agreement with the

importance of these factors to my client. After applying the statistical method (Appendix-L), the route with the highest score was option-1 with a value of 68.

The cost in the airfreight industry is calculated based on chargeable weight per kg. I requested priority rates due to the urgency of the cargo. Each airline charges additional DG fees per UN-number. With the selected option-1 my client would be only paying 3.3% more than the cheapest option. Moreover, the transit time airport-to-airport of 12 hours is significantly faster than the other options.

Sustainability

The sustainability report provided to my client analyzes the TONS of CO_2 to be released per routing option (Appendix-U). The Air Canada flight from Toronto to Lima (Appendix-Y) is one of the most eco-friendly routes, releasing 6.83 TONS of CO_2. Sustainability is a very important factor for every project that we are working on. We are the stakeholders responsible for the climate change action, where our role is a key factor to mitigate CO_2 emissions.

Terms of sale

The seller and the buyer agreed on the purchasing term “Delivered at Place” DAP, Exterminex Warehouse Horacio Cachay Diaz, La Victoria 15034, Peru Incoterms® 2020. It is the seller’s responsibility to move the goods from Newmarket ON, at the buyer’s disposal, ready to be unloaded at the named place of destination. The seller is responsible for all risks until delivery point (CIFFA, 2016). It is the buyer’s responsibility to customs clear the goods.

EXECUTION PLAN

Pre-arrangements

- **Consultant firm on-site inspection**

Before inspection, two out of 346 boxes were accidentally hit by one of the forklifts at the shipper's location. In case of spillage, the MSDS sheet outlines all the safety protocols that need to be followed. Fortunately, there was no leakage, but the consultant firm didn't approve those damaged boxes from the lot to be shipped. Then, the shipper had to provide the revised commercial documentation showing 344 boxes with dimensions 23x16x26 cm and 3.62 kg each. All the boxes were inspected, relabeled, and approved for its transportation via air by the DG consultor.

The DG declaration was filled showing "UN1993, FLAMMABLE LIQUID, N.O.S. (Propan-2-ol) Class 3, PGIII, LTD QTY." (Appendix-P) for air mode of transport. The boxes were overpacked into a D-Container to be shipped by air and were marked and labelled according to the IATA Dangerous Goods Regulations. There were two overpacks, with total gross weight of 1,318.00 kg and each measuring 122x148x122 cm. They were identified in the DG declaration as identical packages A & B (Appendix-S).

- **Obtaining the greenlight to ship to Peru**

I contacted DSV Peru to have everything set up for the smooth movement of the inspected and approved cargo. If the freight arrived without the correct or required documentation, customs fines could be generated. Penalties can vary from USD $150.00 to 2,000.00 and are to be billed to the exporter account. Full Pre-alert for air import shipments needs to be sent at least 48 working hours prior arrival of the freight. All shipment classified as DG, must include the DG Declaration and MSDS with the e-mail pre-alert. The tax ID in Peru is known as the "Registro Único del

Contribuyente" (RUC), and it is mandatory to be in the documentation for actual consignee to avoid any customs clearance delays.

- **Export Customs Clearance**

For every export shipment that is valued at CAD $2,000.00 we need an export declaration to be submitted to the CBSA by the Canadian Export Reporting System (CERS) portal. From June 30th, 2020, the electronic transmission of the export declaration became enforced (EDC, 2020).

The CERS declaration was required to export this freight as the cargo's EXW value was US$ 9,288.00 and HS code of the product 3808.91 stated in the final commercial invoice. CERS number needs to be reported in the MAWB (Appendix-AA).

Pickup

The shipper provided their DG declaration, which I needed to hand to the trucking company as well as the MSDS. I ensured that the trucker was DG certified, and the truck was sent with DG placards affixed to pickup the freight from the shipper's location (Appendix-Z). Any DG exceeding 500 kg being transported must have placards affixed (Transport Canada, 2018). I scheduled the pickup from the shipper's location in Newmarket to be delivered to Toronto airport.

I processed the shipment by sending the e-AWB instructions and e-Manifest to the airline. Then, I put together a pouch for the airline with the following documentation:

- 2 copies of the signed DG declaration
- 2 MAWBs signed
- 1 Manifest

The pre-alert was sent with the above documentation as well as the following:

- HAWB processed electronically (Containing RUC number)
- Commercial invoice (Containing RUC number)
- Packing list
- MSDS

Main Carriage

Once the goods were tendered to the airline, the DG Checklist for a Non-radioactive shipment needed to be filled by the DG specialists receiving the goods prior acceptance of the cargo. The acceptance specialist prepared the Notification to Captain (NOTOC) and attached one copy to the shipment. The planner decided in what position in the aircraft the freight was loaded and added this information to the NOTOC, which informed the pilot what DG were on the aircraft and where they were loaded. The NOTOC includes an Emergency Response Guide code that tells the pilot what actions to take if there is an incident during the flight.

Prior to the flight this shipment of class 3 flammable liquid was stored in the DG section of the warehouse. According to regulations regarding the DG segregation, it must not be stored or transported directly adjacent to a class 5.1 Oxidizing substances shipment.

The two D-Containers were loaded on one PMC pallet. The PMC was brought to the gate by the runner where it was loaded into the aircraft by an FMC Loader. The DG must be loaded on the lower deck of the B767-Freighter because the aircraft only has fire suppression systems in the belly of the plane. In the event of an incident, the crew activates the fire suppression system on the lower deck of the plane. The PMC was pushed into the inside of the aircraft by manpower (Appendix-W). Once it was positioned in the correct location, it was secured with locks located

on the aircraft's floor. When the aircraft landed, the ground handling agent checked in the freight.

During COVID-19 outbreak travel restrictions were enforced. The passenger seats were removed for some of the fleet, and the upper deck was also filled with cargo. That was a resilient solution for the air industry to thrive and keep the flight schedules (Appendix-X).

Delivery

Once the shipment arrived in Peru, it took 72 hours to get it customs cleared. In the shipping documentation the RUC number was clearly stated. Customs clearance was set up based on the sub location code from the airline. This was the importer's responsibility, applicable duties, and taxes were billed to its account. Once the shipment was customs released, DSV Peru arranged the delivery to Exterminex Warehouse with a DG certified trucker.

The figure-2 illustrates the timeline of the shipment.

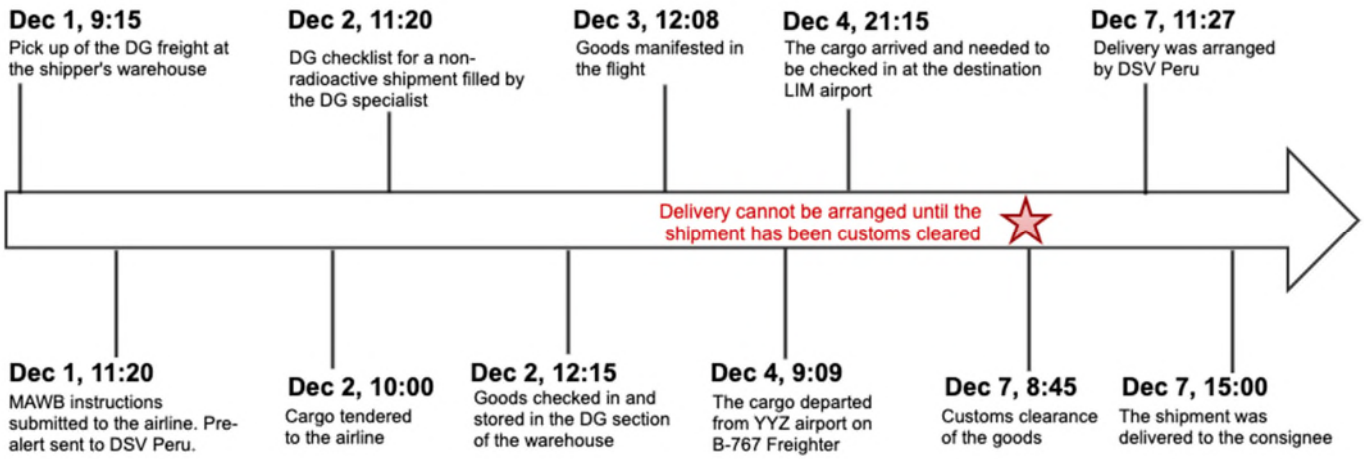

Figure-2. Export shipment timeline

RISK ANALYSIS

The main issue when shifting from an ocean to air DG shipment is that the shipment complies with the regulations to be shipped for that other mode of transportation. I have enlisted the possible risks and counteractions for this project in Table-6.

Table-6. Risks and counteractions

Risk	Counteraction
Cargo not complying with the regulations to be shipped by air	DG Consultant firm hired to inspect the cargo, relabel and overpack the freight
Spillage or leakage of the cargo	Have all the supplies according to the MSDS to take actions in case of an incident/accident
Losing or misplacing one of the boxes during transport	Overpack the boxes for easier handling of the cargo
Incurring storage charges or customs fines at destination	Be in constant communication with DSV Peru office, to confirm that all required documentation is accurate
Damages or loss of the cargo	Proposed my client to purchase All Risk Insurance

INSURANCE

When moving DAP shipments, the shipper bears all risks involved in bringing the insecticide to Exterminex warehouse. For that reason, and to give my client peace of mind, I recommended to add All Risk Cargo Insurance under ICC-A terms. My customer was covered for the commercial value of the goods +freight +10%. The FF liability when shipping goods via air is 22 SDR/kg under Articles 21 and 22 of the

Montreal Convention (ICAO, 2019). By paying USD $137.61, my customer was fully indemnified in the event of loss or damage to the cargo. The All-Risk insurance is rather an investment than an expense. All-Risk insurance not only provides more coverage than FF Liability, but also claims handling time is shorter. The insurance rate is higher for DG commodities because there is a higher risk associated with DG Cargo. Note the DG clause was applicable (Appendix-O).

Goods Value (USD)	+	Freight Value (USD)	+	10%	=	Insurance Value (USD)
$9,288.00		$7,392.20		$1,668.02		$18,348.22

Insurance Value (USD)	x	Selling Rate %	=	Insurance Sell (USD)
$18,348.22		0.75		$137.61

JOB COSTING

PRICING Option-1 Carrier- Air Canada		
Description of Charges		**USD**
Origin charges:		
Handling - Export		124.00
Pickup / Collection (Including DG Fee)		439.00
Inland Fuel Surcharge - 26.80% of (USD 439.00 (PIC))		117.65
THC (Terminal Handling Charge) 0.37/Kg		487.66
Freight – 1,318 kg @ 3.53 USD / kg (Including screening)		4,654.33
NavCan – 1,318 kg @ 0.07 USD / kg		92.26
DG Fees		198.00
Destination charges:		
Delivery		413.00
AHI Airline Handling Fee USD $ 0.35 per kg / vol MIN USD 45.00		461.30
AWI AWB (Air Waybill)		75.00
HDI Handling - Import		105.00
DGI DGR Cargo		75.00
COVID-19 Surcharge		150.00
Remarks:		
All services + VAT 12 %		
The rates are valid 30 days since date that the quotation has been offered		
TOTAL	**$**	**7,392.20**
All Risk Cargo Insurance	**$**	**137.61**

SUMMARY

With COVID-19, the world saw how interconnected we are by people, travel, and our health. The maintenance of global health and wellness is a constant challenge, where resilient transportation methods and strategies need to be in place to either combat a plague or a virus. Freight forwarders play a crucial role moving freight around the globe at the right time for the wellbeing of the population.

The shipment via air of insecticide classified under UN1993 to Peru, to help control mosquito population was successfully delivered. The involvement of the FF in the supply chain to design strategies to expedite urgent supplies highlights how freight forwarders are an essential service. Finally, I illustrated the complexities involved when moving dangerous goods, as they are associated with higher risk to our health, safety, and environment.

CONCLUSION

The movement of goods globally is both challenging and fascinating. There are several aspects to be considered when shipping goods such as terms of sale, commodity, and mode of transport. In this dissertation I have focused on the importance of addressing clients need through teamwork, as well as using statistical tools to make the best decisions. Finally, the inclusion of in-depth analysis and a CO_2 footprint report on the projects, outlines the commitment of customers and logistics professionals to implement sustainable and resilient solutions.

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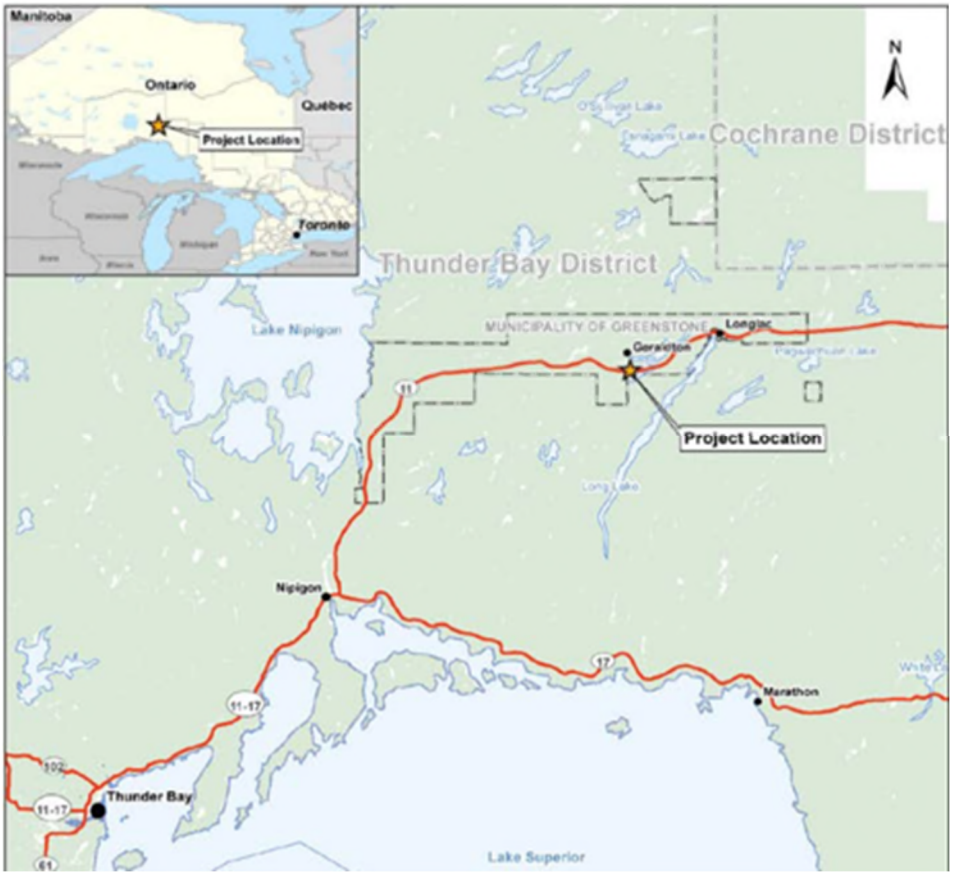
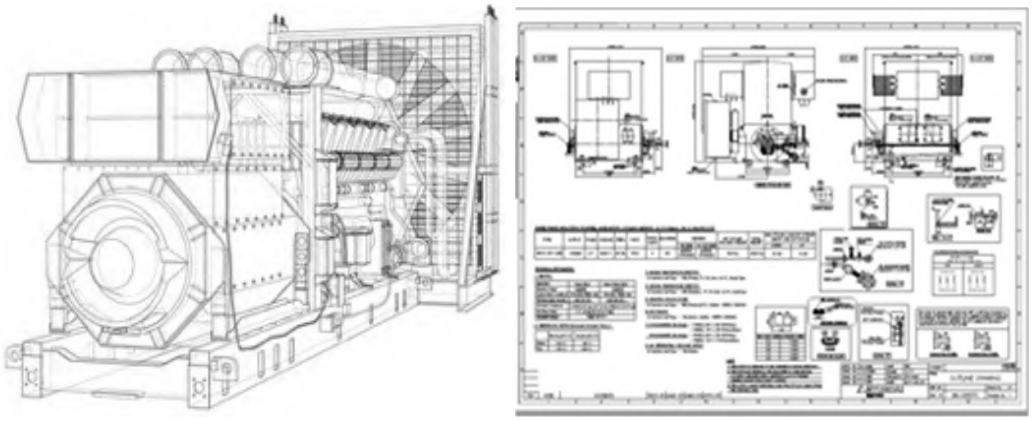
APPENDICES

Appendix-A: Mine location



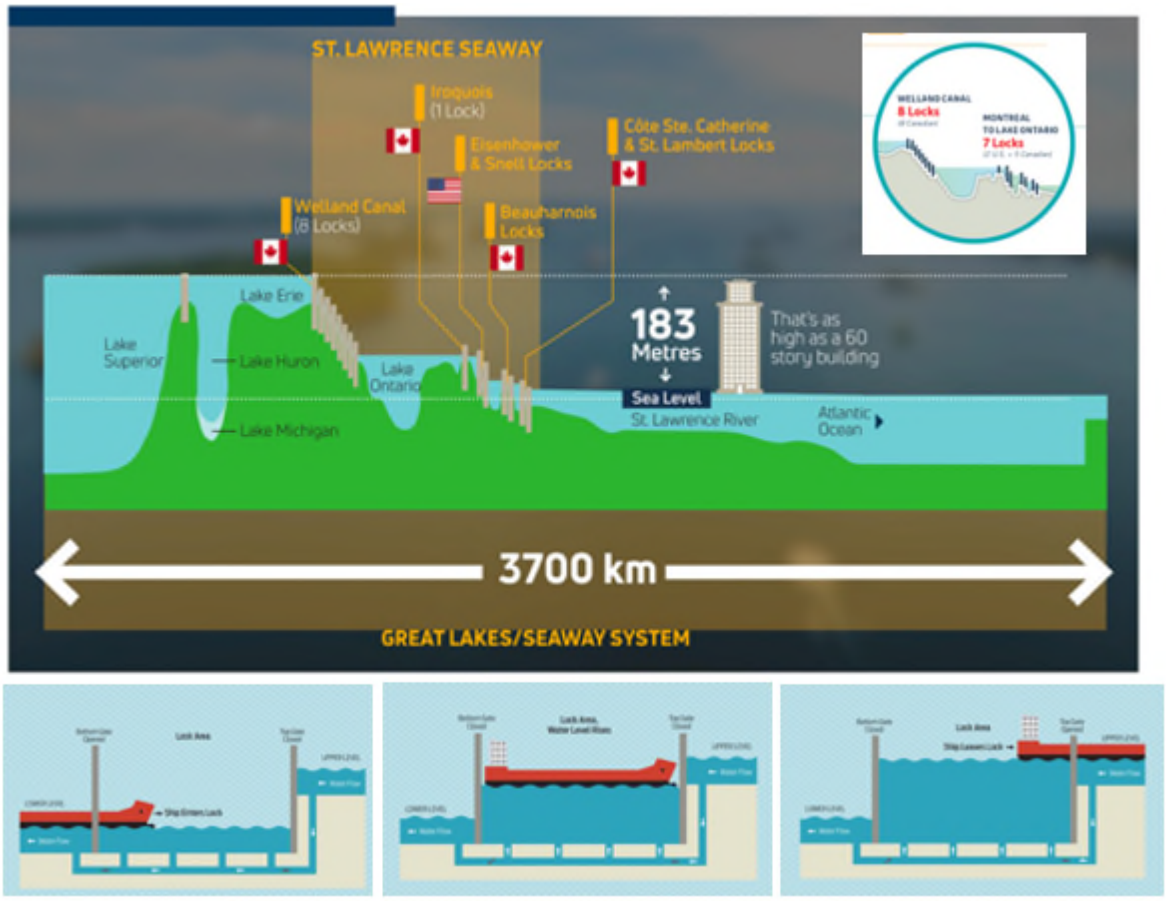
(IAAC, 2018)

Appendix-B: Transportation Drawings-Example.



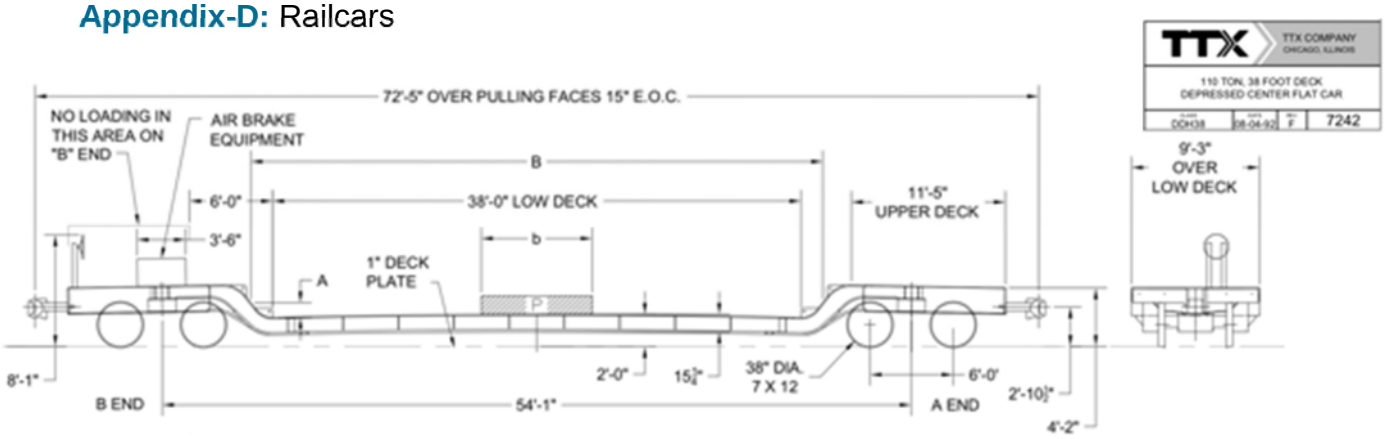
(Chang, 2021)

Appendix-C: Great Lakes/Seaway System and Locks



Source: (Greatlakes-seaway, 2021)

Appendix-D: Railcars



(Leblanc, 2021)

Appendix-E: Caterpillar in Rostock

Source: (Google Earth, 2021)

Appendix-F: MTO-Permit

[redacted] Trip Permit

SN21176961

Ontario

Issued under Section 110 of the Highway Traffic Act (HTA)
Subject to conditions listed throughout all **5** page(s) of this permit.

Permit No. **SN21176961**

Issued by [redacted] Time **15:03:47**

Date [redacted]

Permit Fee: [redacted] Total Fee

Issued To [redacted]

NSC Number **AB2305563**

Address [redacted]

Account No. [redacted]

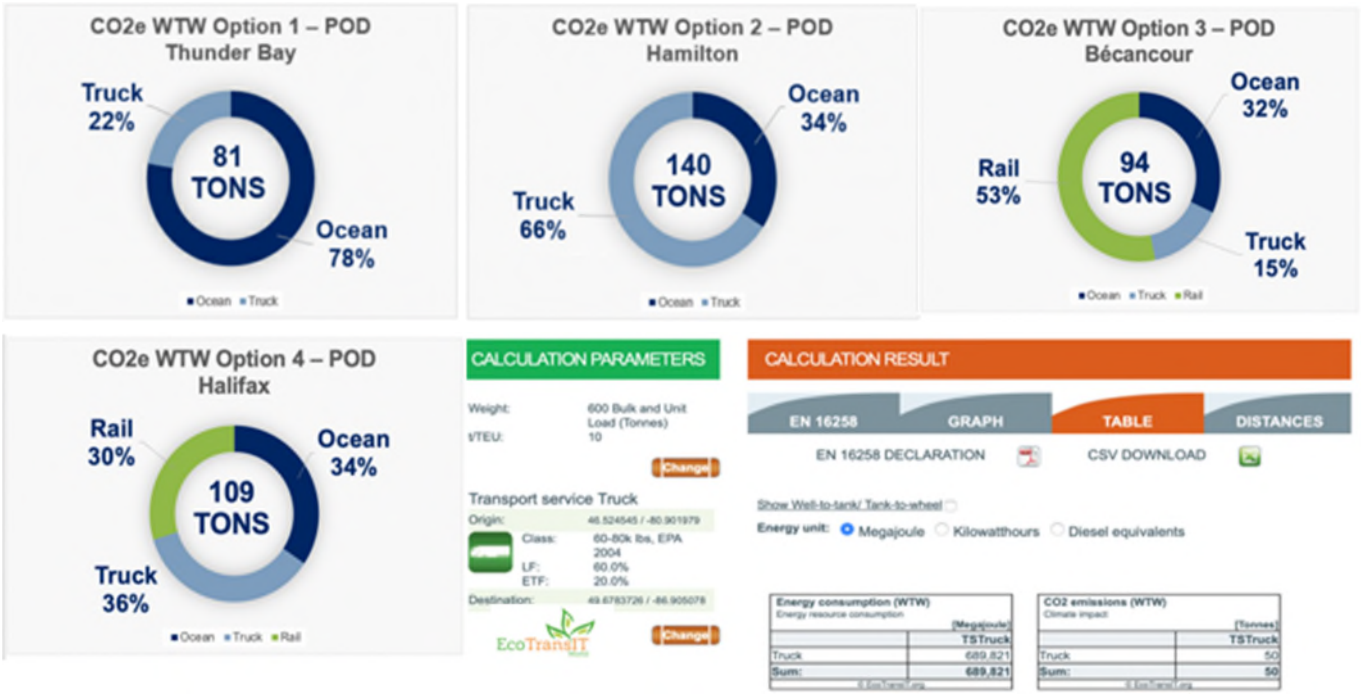
Application No. **285178**

(Leblanc, 2021)

Appendix-G: 13-axle trailers.

(Leblanc, 2021)

Appendix-H: Sustainability report and CO_2 calculation



(EcoTransIT, 2021)

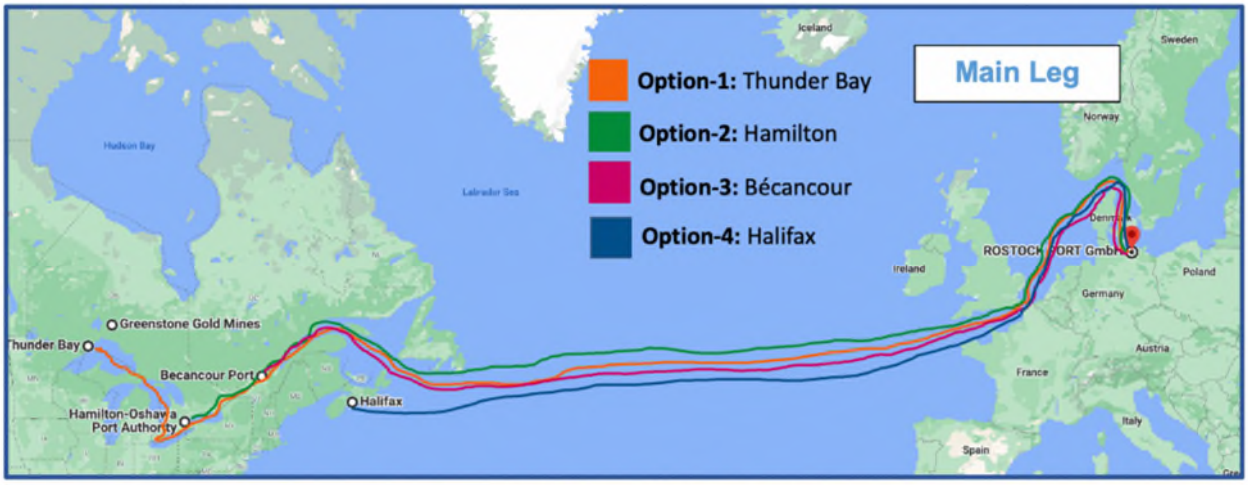
Appendix-I: Direct discharge (vessel-to-railcar)

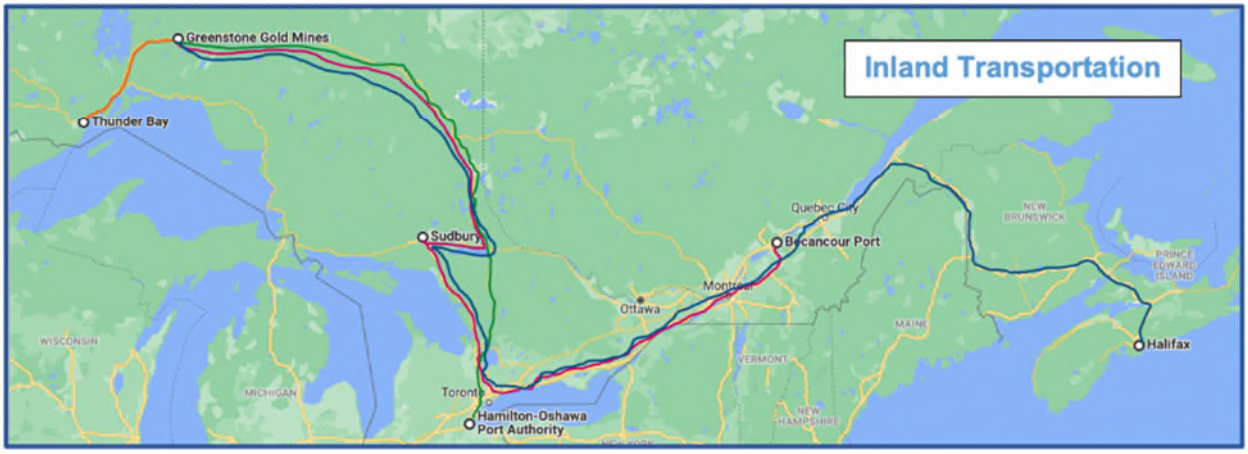
(Lambe, 2021)

Appendix-J: Cost analysis and routing

PRICING	Option-1 Thunder Bay	Option-2 Hamilton	Option-3 Bécancour	Option-4 Halifax
Description of Charges	**USD**	**USD**	**USD**	**USD**
Freight charges:				
Project handling fee (Including BL fee)	558.00	558.00	558.00	558.00
Ocean freight (Full Liner Terms)	1,430,000.00	676,500.00	489,500.00	423,500.00
Destination charges:				
Port charges				
Under hook to direct railcar/truck or place-of-rest*	17,875.00	23,900.00	20,405.00	39,015.00
Place-of-rest to truck or railcar*	16,609.00	9,174.00	19,899.00	47,687.00
Wharfage	1,152.00	1,050.00	1,716.00	4,314.00
Terminal charge	1,134.00	1,300.00	1,410.00	2,224.00
Labour for lashing and securing (8-hour call)	5,374.00	5,900.00	3,512.00	2,769.00
Delivery charges				
Rail Transport to Sudbury, ON			235,578.00	297,609.00
Mobilization for all manpower and labour	3,408.00	17,505.00	35,433.00	35,433.00
Delivery to Greenstone Gold Mine	86,567.00	169,654.00	156,204.00	156,204.00
COVID-19 Surcharge	250.00	250.00	250.00	250.00
TOTAL	**$ 1,562,927.00**	**$ 905,791.00**	**$ 964,465.00**	**$ 1,009,563.00**

*To be billed as applicable.





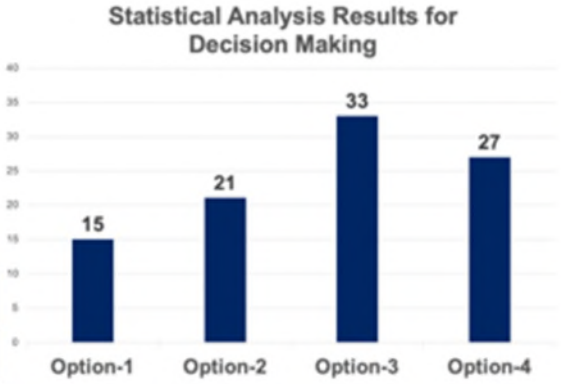
Source: (Google Maps, 2021)

Appendix-K: Statistical analysis-importation

Step	Statistical Analysis Description
1	Normalization of the values, which means adjusting the values measured to a common scale. The highest value of each factor was considered as 100. **Ex. (906*100)/1563 = 57.97**
2	Then, the normalized values were multiplied by the relevance percentage. **Ex. 57.97*0.5=28.98**
3	The values obtained for each factor were summed for every scenario. **Ex. 28.98+20+30=78.98**
4	The total sum of values for each scenario were deducted from the assigned standard value of 100 and rounded up. **Ex. 100-78.98=21**
5	The two options with the highest score were chosen. **33 (Option-3) and 27 (Option-4)**

Port of Discharge	Option	Cost (KUSD)	Transit Time (Days)	CO_2 (Tonnes)	Normalized Values: Cost (KUSD)	Normalized Values: Transit Time (Days)	Normalized Values: CO_2 (Tonnes)
Thunder Bay	1	1563	40	81	100.00	88.89	57.86
Hamilton	2	906	45	140	57.97	100.00	100.00
Bécancour	3	964	37	94	61.68	82.22	67.14
Halifax	4	1010	39	109	64.62	86.67	77.86

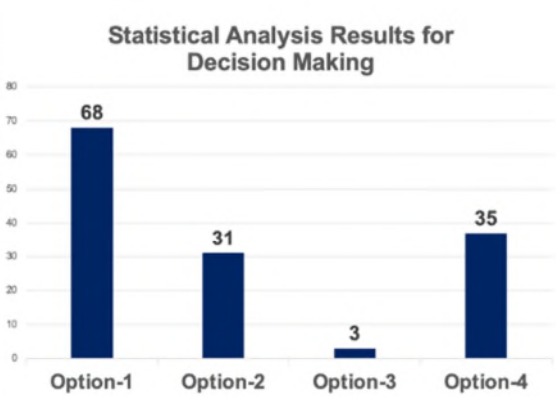
Option	Relevance %: Cost (KUSD)	Relevance %: Transit Time (Days)	Relevance %: CO_2 (Tonnes)	Normalized Values x Relevance: Cost	Normalized Values x Relevance: Transit Time	Normalized Values x Relevance: CO2	Sum of each scenario	Final Value
1	0.5	0.2	0.3	50.00	17.78	17.36	85.13	15
2	0.5	0.2	0.3	28.98	20.00	30.00	78.98	21
3	0.5	0.2	0.3	30.84	16.44	20.14	67.43	33
4	0.5	0.2	0.3	32.31	17.33	23.36	73.00	27



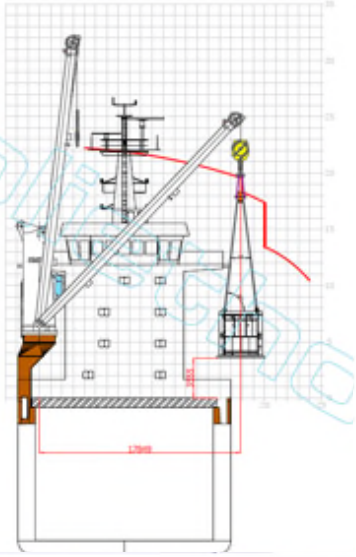
Appendix-L: Statistical analysis-exportation

Airline	Option	Cost (USD)	Transit Time (Hours)	CO_2 (Tonnes)	Normalized Values: Cost (USD)	Normalized Values: Transit Time (Hours)	Normalized Values: CO_2 (Tonnes)
AC	1	7392.2	12	6.83	75.81	10.00	39.25
KL	2	9751.4	49	16.7	100.00	40.83	95.98
BA	3	8265.7	120	17.4	84.76	100.00	100.00
AV	4	7150.5	102	4.81	73.33	85.00	27.64

Relevance %: Cost (USD)	Relevance %: Transit Time (Hours)	Relevance %: CO_2 (Tonnes)	Normalized Values x Relevance: Cost	Normalized Values x Relevance: Transit Time	Normalized Values x Relevance: CO_2	Sum of each scenario	Final Value
0.2	0.5	0.3	15.16	5.00	11.78	31.94	68
0.2	0.5	0.3	20.00	20.42	28.79	69.21	31
0.2	0.5	0.3	16.95	50.00	30.00	96.95	3
0.2	0.5	0.3	14.67	42.50	8.29	65.46	35



Appendix-M: Loading vessel and MBL



Page 2
Shipper, full style & address
DSV AIR & SEA GMBH
[redacted]

10140-190-1

Booking No.: WB.17041
Version 1-2014

Waybill No. # 2 of 2
SIFFVFDHAMR702203

Non-Negotiable (2 pages in total)

splethoff
CEB-WAY EXPRESS
WAY-BILL

Consignee, full style & address
DSV AIR & SEA INC.
[redacted]
CANADA
[redacted]

Voyage nr: 1223
Export ref: CDE223017

Notify Party, full style & address
DSV AIR & SEA INC.
[redacted]
CANADA
[redacted]

NP2:

Carrier (see Clause 1 overleaf)
Splethoff Transport B.V.

Law & Jurisdiction
This Waybill shall be governed by and construed in accordance with the laws of the Netherlands, except as provided elsewhere herein and except for US Trade, as to which the US COGSA 1936 shall apply, and any dispute, claim or action under the contract of carriage evidenced by this Bill of Lading shall be decided by the District Court of Amsterdam, the Netherlands, to the exclusive jurisdiction of which the Merchant (see Clause 1 overleaf) submit himself. The District Court of Amsterdam has non-exclusive jurisdiction in respect of any dispute, claim or action by the Carrier under the contract evidenced by this Way Bill

Pre-carriage by*	Place of receipt by pre-carrier*
Port of loading: Rostock	Port of discharge: Bécancour
Place of delivery by on-carrier*	

Vessel
Fortunagracht

Marks and Nos.	Number and kind of packages; description of goods	Gross weight	Measurement
	AS PER ATTACHED LIST		
	10 items	Total 600,000.00 kg	756.00 cbm

FREIGHT PREPAID
LINER IN HOOK/LINER OUT UNDER HOOK
SHIPPED ON BOARD, 19.06.2017
All terms, conditions, exceptions and any addenda thereto of the governing Worldwide Services Booking-Note dated Bremen, 2nd of June 2017 are hereby expressly incorporated, anything to the contrary in this bill of lading notwithstanding.
The information appearing on the declaration relating to the quantity and description of the cargo is in each instance based on the shipper's load and count.
We have no knowledge or information which would lead us to believe or to suspect that the information furnished by the shipper is incomplete, inaccurate, or false in any way.

U.S. Trade only: Declared value,
If any (as Clause 6.2 overleaf)

Particulars, including contents etc. are furnished by the Merchant but not acknowledged by the Carrier, unless the contrary has been expressly agreed. The signing of this Waybill is not to be considered such an agreement.

Freight payable at	Freight details, charges etc.
Bremen	

RECEIVED for [forwarding and*] shipment in apparent good order and condition, unless otherwise stated in this Bill of lading, the Goods mentioned above (contents and condition, measurement, weight, quantity, marks, numbers, quality and value unknown), to be carried, **subject to the terms, conditions and exceptions overleaf**, to the Port of Discharge or so near thereunto as the Vessel may safely get and lie always afloat at all times of the tide. The Carrier will deliver the Goods at the Port of Discharge to the Consignee named, or his authorised agents, on production of proof of identity. Should the Shipper require delivery to a party other than as shown in the Consignee box, written instructions must be given to the Carrier or his Agent before arrival at the Discharging Port, unless the Shipper has transferred his right to control the Goods to the Consignee by means of a clause on the face of this Bill of lading. The Carrier will, subject to the terms, conditions and exceptions overleaf, process cargo claims with the Shipper, unless the Shipper has expressly transferred his right to control the Goods to the Consignee as aforesaid. Claim settlement, if any, shall be a complete discharge of Carrier's liability to the Shipper. The Shipper accepts the terms, conditions and exceptions overleaf on his own behalf, on behalf of the Consignee and the Owner of the Goods, and authorises the Consignee to bring suit against the Carrier in his own name but as agent of the Shipper and warrants that he has authority so to accept and authorise. The Shipper further undertakes that no claim or allegation in respect of the Goods shall be made against the Carrier by any person other than in accordance with the terms, conditions and exceptions overleaf. The Carrier shall exercise due care ensuring that delivery is made to the proper party. The Carrier however accepts no responsibility for incorrect delivery, unless due to Carrier's personal fault or neglect.

(Rodrigues, 2021)

Appendix-N: Accident example.

(CIFFA, 2014)

Appendix-O: DG-Clause

Dangerous Goods Clause

In respect of dangerous goods, cover hereunder shall be subject to the following terms conditions warranties limitations exceptions and exclusions:

1. Warranted that all appropriate documentation such as (but without prejudice to the generality of this clause) import and/or export permits and licences, shall be in good order prior to the attachment of risk under this Policy.

2. Warranted that the IMDG Code and other IMO Codes of safe practice are adhered to.

Appendix-P: DG declaration-(Air).

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

IATA

Shipper

Insectron Inc.
16655 Yonge St,
Newmarket, ON L3X 1V6,
Canada

Air Waybill No. 014 2082 5733

Page 1 of 1 Pages

Shipper's Reference No. TOR0068875 (optional)

Consignee

Exterminex Warehouse
Horacio Cachay Diaz,
La Victoria 15034
Lima, Peru

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for:

(delete non-applicable)

PASSENGER AND CARGO AIRCRAFT | ~~CARGO AIRCRAFT ONLY~~ XXX

Airport of Departure (optional): Toronto

Airport of Destination (optional): Lima

Shipment type: *(delete non-applicable)*

NON-RADIOACTIVE | ~~XXXXXXXXXX~~

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification						
UN or ID No.	Proper Shipping Name	Class or Division (subsidiary hazard)	Packing Group	Quantity and Type of Packing	Packing Inst.	Authorization
UN 1993	FLAMMABLE LIQUID, N.O.S. (Propan-2-ol) LTD QTY	3	III	172 Fibreboard boxes x 3L Overpack used x 2 A, B Total quantity per overpack 516 L	Y344	

172 x 2 = 344 boxes

Additional Handling Information

24 hour emergency response no. +1-905-845-7223

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. I declare that all of the applicable air transport requirements have been met.

Name of Signatory: Bill Smith

Date 4/20/2022

Signature *(See warning above)*

Signed by the shipper

Appendix-Q: Packing Instruction-Y344

PACKING INSTRUCTION Y344

STATE VARIATIONS: BEG-03 OMG-03 SAG-01 USG-04 YEG-05

OPERATOR VARIATIONS: 4Y-01 AM-03 CX-02 DE-01 FX-02 GA-03 GF-04 JU-06 KC-11 KE-07 KQ-08 LD-02 LH-01 LX-02 MH-14 OS-01 OU-04 PX-10 SW-02 TN-04 UX-02 VT-01 WB-07 WY-01 WY-04 X5-02 XK-03 XQ-01

This instruction applies to Limited Quantities of flammable liquids with no subsidiary hazard in Packing Group III.

The General Packing Requirements of Subsections 2.7.5, 5.0.2 to 5.0.4 (with the exception of 5.0.2.3, 5.0.2.5, 5.0.2.11 and 5.0.2.14.2) must be met except that the packagings do not have to meet the marking and testing requirements of 6.0.4 and Subsection 6.3. Packagings must meet the construction criteria specified in Subsections 6.1 and 6.2 and the test criteria specified in Subsection 6.6.

Compatibility Requirements

- substances must be compatible with their packagings as required by 5.0.2.6.

Closure Requirements

- closures must meet the requirements of 5.0.2.7.

Limited Quantity Requirements

The requirements of Subsection 2.7 must be met including:

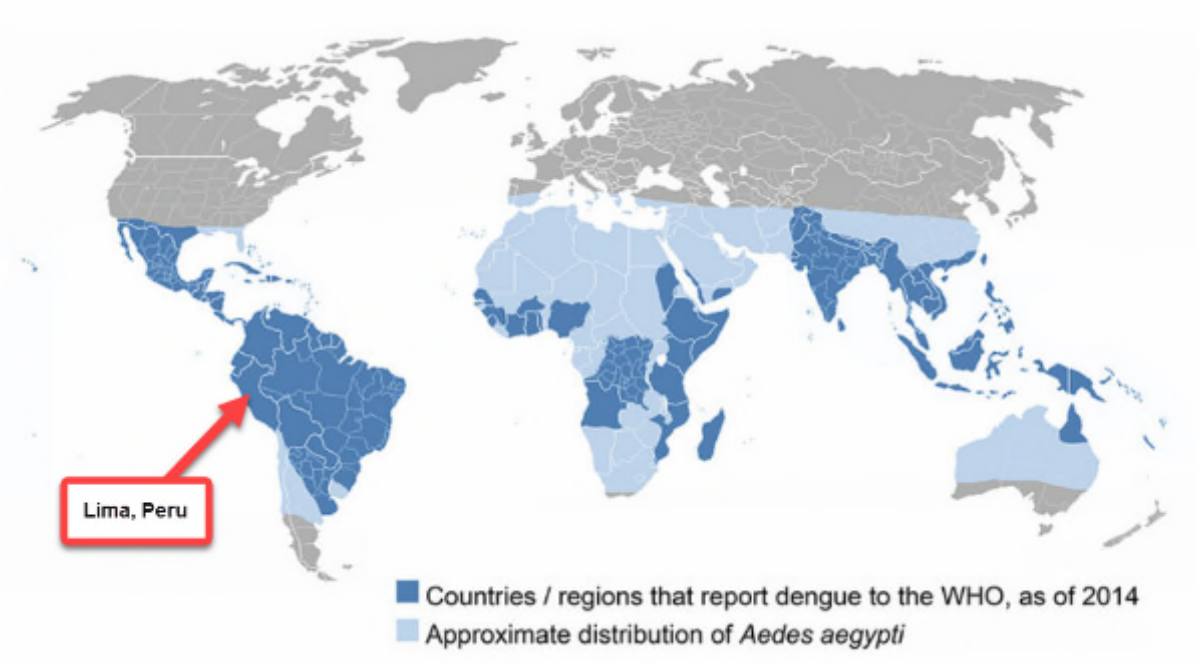
- the capability of the package to pass a drop test of 1.2 m;
- a 24 hour stacking test;
- inner packagings for liquids must be capable of passing a pressure differential test (5.0.2.9);
- the gross weight of the completed package must not exceed 30 kg.

Single packagings are not permitted.

COMBINATION PACKAGINGS

Inner Packaging (see 6.1)	Net quantity per inner packaging	Total net quantity per package
Glass	2.5 L	10.0 L
Metal	5.0 L	
Plastic	5.0 L	

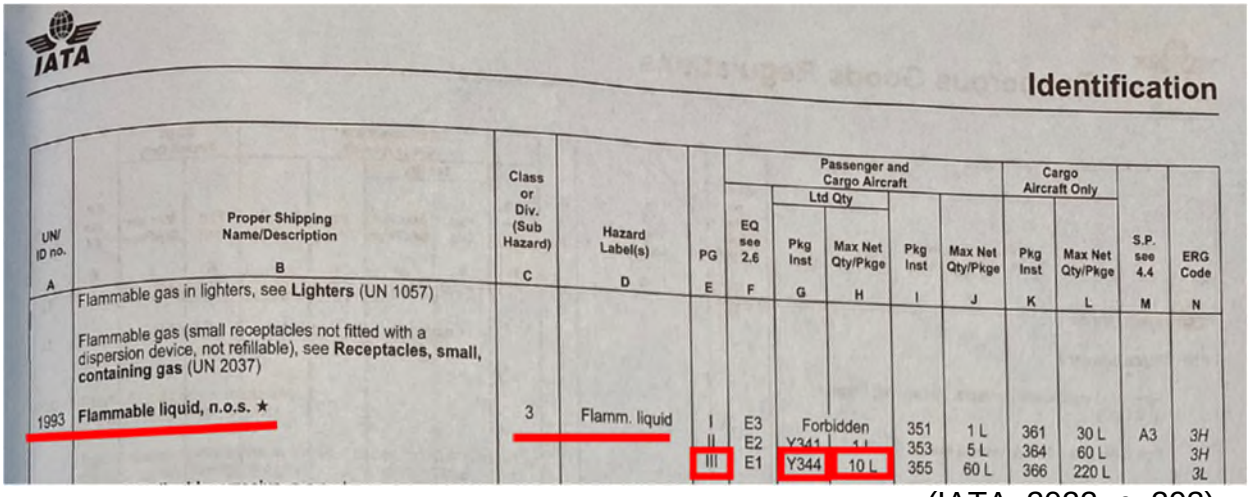
Appendix-R: Mosquito population map.



Source: (YaleNews, 2020) https://news.yale.edu/2020/08/17/researchers-track-origin-one-natures-biggest-killers

Appendix-S: Packaging and labeling

Appendix-T: IATA-DG book, UN 1993.



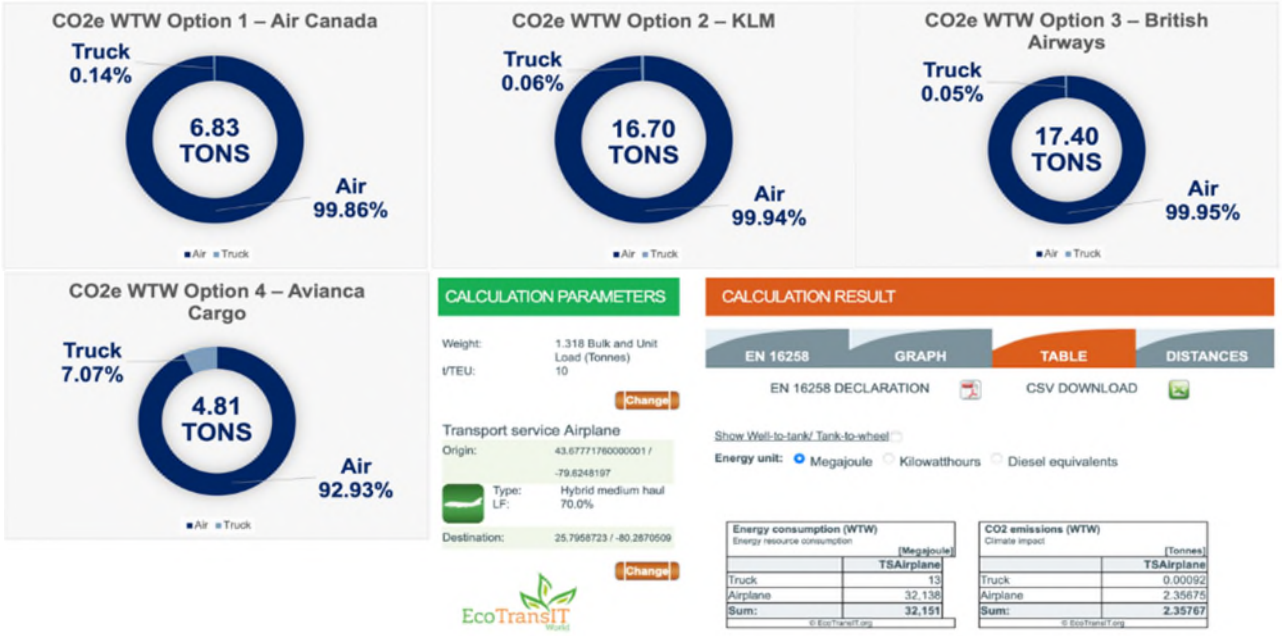
IATA

Identification

UN/ ID no. A	Proper Shipping Name/Description B	Class or Div. (Sub Hazard) C	Hazard Label(s) D	PG E	Passenger and Cargo Aircraft EQ see 2.6 F	Ltd Qty Pkg Inst G	Ltd Qty Max Net Qty/Pkge H	Pkg Inst I	Max Net Qty/Pkge J	Cargo Aircraft Only Pkg Inst K	Cargo Aircraft Only Max Net Qty/Pkge L	S.P. see 4.4 M	ERG Code N
	Flammable gas in lighters, see **Lighters** (UN 1057)												
	Flammable gas (small receptacles not fitted with a dispersion device, not refillable), see **Receptacles, small, containing gas** (UN 2037)												
1993	**Flammable liquid, n.o.s.** ★	3	Flamm. liquid	I	E3	Forbidden		351	1 L	361	30 L	A3	3H
				II	E2	Y341	1 L	353	5 L	364	60 L		3H
				III	E1	Y344	10 L	355	60 L	366	220 L		3L

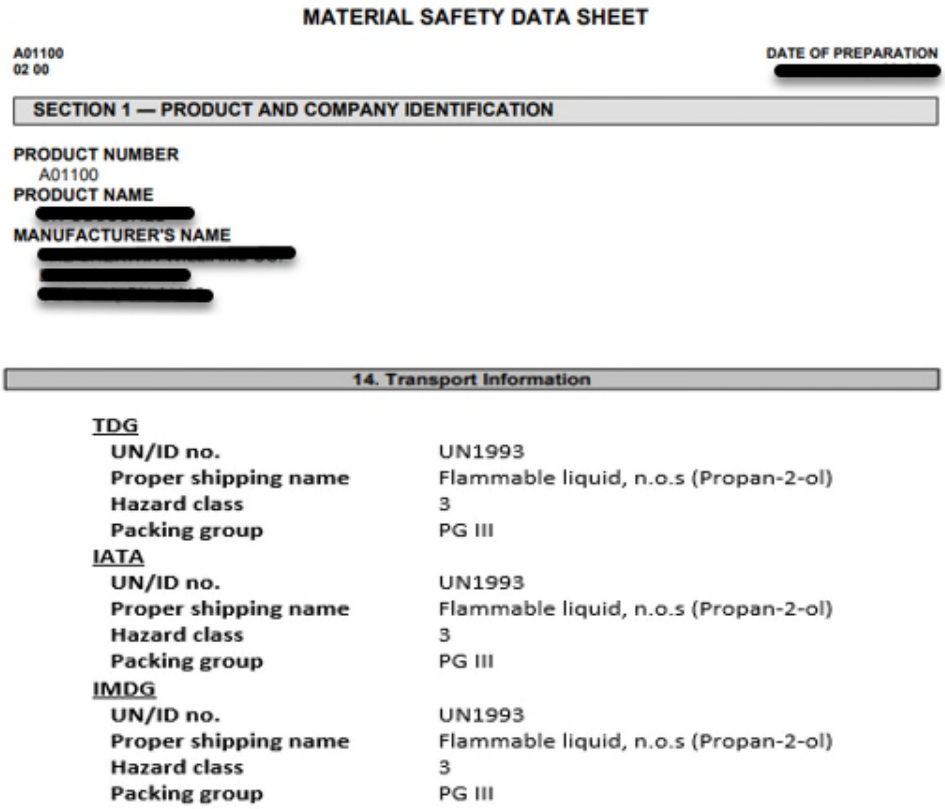
(IATA, 2022, p. 293)

Appendix-U: Sustainability report and CO_2 calculation



(EcoTransIT, 2021)

Appendix-V: MSDS



MATERIAL SAFETY DATA SHEET

A01100
02 00

DATE OF PREPARATION [redacted]

SECTION 1 — PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NUMBER
A01100
PRODUCT NAME
[redacted]
MANUFACTURER'S NAME
[redacted]

14. Transport Information

TDG	
UN/ID no.	UN1993
Proper shipping name	Flammable liquid, n.o.s (Propan-2-ol)
Hazard class	3
Packing group	PG III
IATA	
UN/ID no.	UN1993
Proper shipping name	Flammable liquid, n.o.s (Propan-2-ol)
Hazard class	3
Packing group	PG III
IMDG	
UN/ID no.	UN1993
Proper shipping name	Flammable liquid, n.o.s (Propan-2-ol)
Hazard class	3
Packing group	PG III

Appendix-W: Loading aircraft

Source: (Air Canada, 2022)

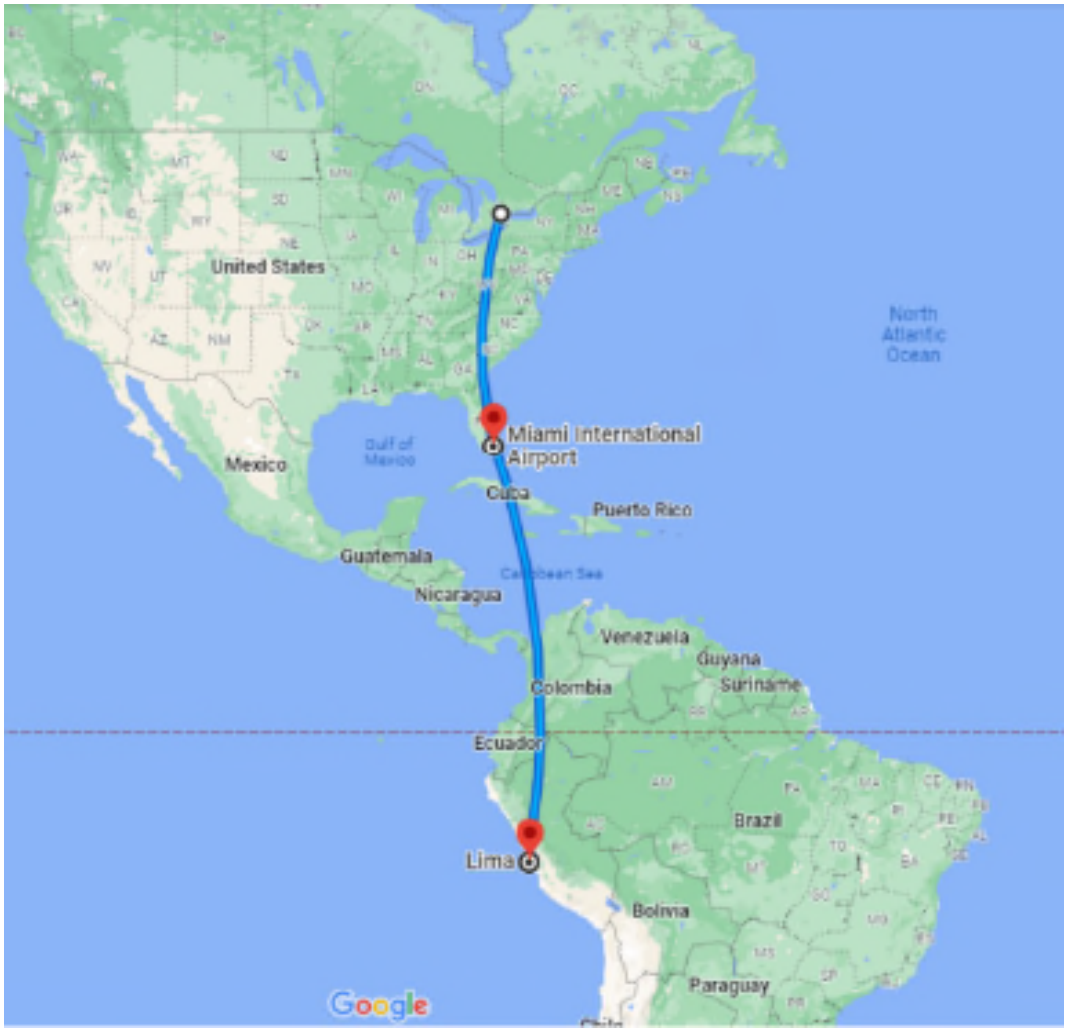
https://mraircanada.mediaroom.com/air-canada-cargo

Appendix-X: Freighter

Source: (Air Canada, 2022)

https://mraircanada.mediaroom.com/air-canada-cargo

Appendix-Y: Routing Air Canada (YYZ-LIM)



Source: (Google Maps, 2022)

Appendix-Z: DG-Road transportation

(Transport Canada, 2018)

Appendix-AA: MAWB