Feasibility of Underground Short-Haul Freight Pipelines- Application to the DFW Airport

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Chapter One: INTRODUCTION AND SCOPE

Advantages of the System

- Reduce the truck traffic
- Improve safety
- Enhance Efficiency
- Improve Air quality
- Help Private shippers (FedEx, UPS, U.S. postal service)
- Reduce adverse environmental impacts such as emissions and noise

The proposed UFT line:

- Transports standard air crates
- One end of the line is the airport Delta/United cargo terminal
- The other end is a warehouse off the secured airport area
Selection Criteria

- Close to the major highways
- Consistent land use with surrounding (industrial)
Suggested Locations According to the DFW Masterplan:

- Northwest Logistic
- International Commerce Park
- Proposed Intermodal Freight Terminal

1. Congested surrounding highways (121,114)
2. Longer UFT line lengths
3. Interrupting taxiways during construction
Chapter Two: Freight Size and Dimensions

- **Type:** International Air Transport Association (IATA) A-2 crate
- **Suitable for:** B747, B747F, DC8, DC10, A300/F
- **Size:** 125 inches long, 88 inches wide, 79 inches high (317 cm × 223 cm × 200 cm)
- **Maximum gross weight:** 13300 lbs. (6.033 kg)
- **Internal Volume:** 445 ft³ (12.6 m³)
Chapter Two: Design of Tunnel and Vehicles

- **Tunnel section:** Cylindrical
- **Tunnel depth:** 40 ft.
- **Propulsion system:** Linear Induction Motors (LIMs)
- **Crate dimension:** (7.8 W× 7.5 H× 14.3 L)
- **Vehicle type:** Open flat-bed with a rectangular cross-section
Chapter Two: Design of Tunnel and Vehicles
Chapter Two: Design of Terminal

Schematic design

1. Two similar sections → Loading Unloading

2. Terminal has two lines: a truck line and an access line

3. The total area of the terminal without access roads is 21,700 sq. ft

4. Managerial Building 1,800 sq. ft

5. Storage capacity of 70 crates

6. Two layover/maintenance rails

7. Two truck stations → Loading Unloading

8. 8-inch thick concrete pavement

9. Four forklifts + One back-up forklift
Chapter Three: OPERATIONAL ATTRIBUTES

Operational Attributes

- Running Gear Systems: Steel wheel and rail
- Speed: 51 mph
- Headway: Six minutes
- Terminal dwelling time: One minute
- Trip time: Two minutes
- Capacity: 240 crates per direction per day
- Number of forklifts: Four Operating + One Backup in each terminal
Chapter Four: CONSTRUCTION METHODS AND COST ANALYSIS

Construction Methods and Cost Analysis

- GEOLOGICAL AND GEOTECHNICAL STUDY
- CONSTRUCTION OF TUNNELS
- CONSTRUCTION OF SHAFTS AND ENTRY/EXIT RAMPS
- CONSTRUCTION OF TERMINALS
- COST ANALYSIS

DFW - DALLAS FORT WORTH INTERNATIONAL AIRPORT
Chapter Four: GEOLOGICAL AND GEOTECHNICAL STUDY

Construction Methods and Cost Analysis

Sources for geological and geotechnical studies:

- Geological Atlas of Texas (USGS 2017)
- Two previous DFW Airport projects:
  - Express North (W1) Parking Expansion
  - DFW DPS Headquarters 2900 E Street

Different soil layers:

- Top soil
- Stiff Lean Clay (CL)
- Stiff to very stiff Fat Clay (CH)
- Gray hard Shale (Shaley Clay)

Groundwater level fluctuation

14 to 40 ft. below the surface

Need for dewatering
Chapter Four: CONSTRUCTION OF TUNNELS

Construction Methods and Cost Analysis

GEOLOGICAL AND GEOTECHNICAL STUDY

CONSTRUCTION OF TUNNELS

CONSTRUCTION OF SHAFTS AND ENTRY/EXIT RAMPS

CONSTRUCTION OF TERMINALS

COST ANALYSIS

Tunneling:

**Tunnel Boring Machine (TBM)**

- Reinforced precast concrete segments
- 20% slope ramp
- 13-ft. diameter access shaft (3,500 ft. from the UFT origin terminal)
- 75 ft. of the tunnel entry/exit ramps (cut-and-cover method)

Disposal of Tunnel Spoils:

*Continuous Belt Conveyor System*

http://agjv.no/news/30-inside-the-tbm
Supporting Shaft and Tunnel Entry/Exit Ramp Walls:

Soldier Pile and Lagging Method

- fast-to-construct
- cost effective

Dewatering For Construction of Access Shaft and Tunnel Entry/Exit Ramps:

Pumping Method

The main purpose:
- Facilitate installation of the support systems.
- Improve soil stability allowing excavation to proceed in dry conditions.
Chapter Four: CONSTRUCTION OF TERMINALS

Construction Methods and Cost Analysis

- 16,200 square feet of pavement for the access and stacking areas
- 8-inch thick reinforced concrete slabs
- 1,800 square feet office building (one-story timber office buildings) including office space, storage, operation rooms, and restrooms
Chapter Four: COST ANALYSIS

Capital Costs of The UFT (2016 dollars)

<table>
<thead>
<tr>
<th>Cost Components</th>
<th>Costs ($)</th>
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<tbody>
<tr>
<td>Tunnel Construction</td>
<td>28,730,700</td>
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<tr>
<td>Tunnel Entry/Exit Ramp</td>
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<td>Tunnel Invert Concrete</td>
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<td>Terminal Development</td>
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<td>Tracks</td>
<td>1,576,903</td>
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<tr>
<td>Freight Vehicles</td>
<td>84,000</td>
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<tr>
<td>LIM System</td>
<td>125,000</td>
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<tr>
<td>Forklifts</td>
<td>900,000</td>
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<td><strong>Total</strong></td>
<td><strong>33,842,520</strong></td>
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Annual Costs of The UFT (2016 dollars)

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<thead>
<tr>
<th>Cost Components</th>
<th>Costs ($/year)</th>
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<tr>
<td>Tunnel Operation and Maintenance</td>
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<tr>
<td>Terminal Maintenance</td>
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<tr>
<td>LIM Maintenance</td>
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<tr>
<td>LIM Power Consumption</td>
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<td>Terminal Electricity Consumption</td>
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<td>Forklifts Electricity Consumption</td>
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<td>Administrative Cost</td>
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<td><strong>Total</strong></td>
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Questions


