

Appendix B. Transmission Line Repair Materials for Earthquake Damage

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Technical Memorandum

Water Supply Forum – Regional Resiliency Project

To: Andrew Graham, HDR Project Manager
From: Don Ballantyne, Ballantyne Consulting LLC
Date: July 26, 2018
Subject: Transmission Line Repair Materials for Earthquake Damage (Task 202.1)

1.0 Introduction

This memorandum discusses the estimation approach and results for the number, type, and diameter of repair materials required for the most damaging earthquake scenario affecting large-diameter water transmission lines. The transmission lines considered are owned by Everett Public Works, Seattle Public Utilities (SPU), Tacoma Water and Cascade Water Alliance.

In Phase 1 of the Regional Resiliency Project, transmission pipeline repair estimates were calculated for Everett and SPU for each diameter and each material. These were calculated for each of the scenarios evaluated in Phase 1. Tacoma Water had recently completed its seismic assessment and provided pipeline repair information for each scenario (except the South Whidbey Island Fault [SWIF]), for each pipe material on each transmission pipeline, but not for each diameter. The Cascade Water Alliance (CWA) only owns the Bellevue Issaquah Pipeline – they provided pipe repairs for that pipe.

This project evaluated the expected performance of the supply, transmission, and backbone systems made up primarily of steel and concrete cylinder pipe. The study estimated that approximately 180 repairs would be required on the regional pipe systems following a Cascadia Subduction Zone (CSZ) earthquake. Task 202.1 of this project quantified the expected pipe failures by pipe type and diameter, estimating the required repairs materials needed, and identifying the repair materials on hand as of late 2017.

For this technical memorandum, the transmission pipeline repair information data for the particular scenario for each utility being evaluated was sorted first by pipe diameter and then by material. Where repair materials could potentially be shared, they are summed up across multiple utilities.

Distribution systems were not studied in detail in this project. However, based on distribution pipe damage estimated by the major utility participants in this study, there will be approximately 5,000 distribution pipeline repairs required throughout the region including non-WSF utilities. This estimate considers the number of repairs required in the major utility systems and extends it to the entire region based on population. It takes into account that many of the smaller city utilities have newer pipe materials that are less vulnerable to earthquakes. It is believed that regional utilities and warehouses only stock a small percentage of the repair materials required to make 5,000 repairs. A future WSF project recommendation would be to develop a better estimate of the expected repairs, the number of repair materials in the region, and develop a plan to acquire the repair the remaining required materials immediately following an earthquake. The plan would likely consider acquiring/warehousing a small percentage of the repair materials (considering the shelf life of gaskets) and develop a plan to acquire the balance from across the country following the event.

The remainder of this technical memorandum addresses the transmission systems, rather than distribution system repairs.

2.0 Assumptions

The following assumptions were made in estimating transmission pipe damage and repair materials:

1. Started with spreadsheet calculation for number of repairs using the ALA methodology.
2. Pipe materials/joints included:
 - Steel – welded (some in Everett system 1931 vintage)
 - Steel – gasketed
 - Concrete Cylinder Pipe (CCP) – gasketed
 - Ductile Iron Pipe (DIP) – gasketed (some in Everett system may be welded)
3. Pipe sorted by diameter, material and joint type.
4. Calculated subtotals for pipe by diameter, material and joint type
5. Assumed failures per group of less than 0.1 (i.e. 10 percent chance of one failure in a given size class) do not need repair materials to be stockpiled.
6. Estimated repair materials based on the type of hazard:
 - Peak Ground Velocity (PGV) causes joint cracking,
 - Permanent Ground Deformation (PGD) causes joint separation and offset.
7. Assumed pipe repair materials could be used for the highest-pressure class for that diameter pipe.
8. Steel and Concrete Cylinder Pipe (PCCP) repaired with steel pipe and butt straps; Ductile Iron Pipe (DIP) repaired with pipe and Dresser couplings
9. In some cases, it is assumed that only partial lengths of pipe are required.

3.0 Results

The results are presented in Table 1. These are general findings and could be improved with more detailed assessment by the individual utilities. Transmission pipes are sorted by diameter and type. Ownership by the four utilities is listed in column 2 and represented by color as defined in the table's legend. Where multiple utilities have similar pipes and would require similar repair materials, they are summed.

The two columns at far right in Table 1 list repair materials the utilities currently maintain (February 2018). Empty cells indicate the utility did not report having materials on hand for the combination of pipe diameter and materials listed in the respective row.

There would be some value in sharing stockpiles of repair materials. There are:

- 3 diameters (60-, 51-, and 48-inch) for which 3 utilities would need repair materials (red cells in Table 1)
- 10 diameters (96-, 78-, 54-, 52-, 42-, 36-, 30-, 24-inch steel; 24- and 20-inch DIP) for which 2 utilities would need repair materials (orange cells in Table 1)

Among the four utilities considered, Cascade Water Alliance has the least amount of transmission lines and it currently has adequate materials for repair of its transmission system in the event of the largest scenario considered.

4.0 Pipe Vendors

Vendors that could potentially serve as a source of transmission pipe repair materials include:

Local Vendors

- Consolidated Supply
- Familian NW, Kent, WA - ductile iron pipe and appurtenances
- Ferguson Enterprises,
- HB Jaeger/Corix
- HD Fowler, Pacific, WA - ductile iron pipe and appurtenances
- HD Supply Waterworks, Puyallup WA - ductile iron pipe and appurtenances
- Streich Bros., Tacoma, WA – Local fabrication shop

Large Diameter Steel Pipe Vendors

- American Cast Iron Pipe Company - Birmingham, AL - welded steel and ductile iron pipe
- Ameron International Water Transmission Group - welded steel pipe
- Northwest Pipe, Portland Oregon - welded steel pipe

National Vendors

- Romac Industries, Seattle - Transition Couplings and Fittings

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Diam (in)	Owner	Pipe Material	Repairs Grouped by Diam and Jt	Pipe Segments Needed	Connections/ Joint Repair Number	Total Pipe segments	Total Pipe (ft) (assume 20'/segment)	Total Joint Repair	Repair Pipe On Hand (ft)	Other Repair Materials On Hand
30	S	Concrete Cylinder	0.26	0	2					
30	E	Concrete Cylinder	0.60	0	2					
30	S	Steel	1.39	2	4					
30	E	Steel	0.40	0	2				1	2 sleeves
30	T	Steel	1.14	1	3				217	
30	Total					3	60	13		
24	S	Concrete Cylinder	0.42	1	2					
24	T	Steel	0.26	1	2				1250	
24	E	Steel	0.00	0	0					18 sleeves
24	Total					2	40	4		
24	C	Ductile Iron		2	7				60	2 sleeves
24	T	Ductile Iron	0.07	0	0					
24 DIP	Total					2	40	7		
20	S	Cast Iron	1.24	2	4					
20	T	Cast Iron	0.24	0	1					
20	Total					2	40	5		
18	T	Steel	0.05	0	0	0	0	0		
	Total		179.14	162	446		3060	427	3465	

Legend

- Everett
- SPU
- Tacoma
- Cascade

- 2 utilities using this diameter
- 3 utilities using this diameter

- DIP Ductile iron pipe (all other repair materials steel)