



JOB DEMANDS ANALYSIS

Company: Greater Vancouver Regional District **Location:** All Plants

Job Title: WWTP – Pipefitter **Classification:** Regular Duty

Work Demand Level: Medium to Very Heavy

Purpose of Activities

The purpose of the duties of the Sewer Plant Pipefitter is to carry out repairs, maintenance and new installations of pipe in the wastewater plant (Annacis Island, Lulu Island, Iona and Lion's Gate).

Tools and Equipment

The mechanic will use the following tools and equipment to perform their duties:

- Gloves.
- Safety Hat
- Safety Boots.
- Safety Vest.
- Electric cart.
- Variety of hand and power tools including impact tools and large crescent wrenches.
- Come-along
- Hammers (ballpeen)
- Pipe Stands
- Pipe Cutter (Zipwheel)
- Cutting Torch
- Hand Grinder
- Flashlight

Usual Methods

The job varies substantially from day to day as they may be involved in smaller instrument piping jobs or in large heavy runs of pipe. There can be considerable lifting and carrying of pipe. Stair-climbing is common as is turning valves by hand. They would spend no more than 30 minutes a day engaged in seated paperwork related duties such as estimating part requirements. They can be seated for brief periods of time when working at benches. They are working with a variety of tools throughout the day ranging up to a 48" pipe wrench. Many of the larger tools are

made from aluminum which significantly reduces their weight and improves their ease of handling considerably. The wrench work can be significant in terms of volume and in terms of awkward positioning combined with near maximal force development.

In the field, they may have to use large, heavily leveraged tools such as a pipe wrench in very awkward positions. These positions can include extended kneeling or crouching in addition to reaching and considerable spinal flexion. Many connections are positioned at knee level from the floor. In order to work on these, the workers' are required to kneel or crouch for long periods of time. Many other pipes are set well above the floor and require the Pipefitter to work off of ladders or staging and often with the arms elevated above the head. It is also common on these situations to have to work around other obstructing objects.

The plants using chlorination processes require an annual overhaul of the piping and other components of the chlorine and sulphur dioxide process. This project consumes a large portion of the pipefitter's activities each year. It requires a large variety of postures including prolonged kneeling, bending and standing. It involves working with small pipes and valves through to the larger sections of pipe including overhead and ladder work. The chlorine processes tend to be largely housed in older parts of the plants, so there is more congestion and less attention to person access issues.

The plant they are working in can also dictate some of the demands of the work. Annacis (in particular) and Lulu are more spacious and feature more hoists and cranes. The newer pumps and motors are also set on higher footings so that it is not necessary to work as close to floor level. The older plants tend to be more congested and the equipment is often set lower to the ground. It is more likely that block and tackle will have to be used instead of using hoists and forklifts.

Administrative Issues

Typically they work an eight - hour day from Monday to Friday (0600 – 1530 with 30 minute lunch and two breaks). Most of the work is conducted indoors (outdoors is possible but less likely) and can include exposure to raw sewage and the risk of dangerous gases (such as H₂S). They have assistance of labourers for some heavy tasks. They may also work in conjunction with contractors on some larger projects.

Activity Demand Variables

These variables are tasks that must be carried out by the employee and are implicitly or explicitly required as objectives of the job.



- Work in some confined spaces.
- Walk over concrete and stairs.
- Climb up and down ladders.
- Carry out some tasks under unpredictable outdoor conditions that often include steady rainfall.
- Exposure to sewage.
- Awkward equipment located close to the floor or overhead (equipment dictates posture).

Worker Decision Variables

These variables are the sub-routines and cognitive/physical decisions made by the worker in carrying out the objectives of the job.

- Choose postures for carrying out duties (e.g. lifting using hips and maintaining neutral spine, creative energy saving techniques).
- Planning of precise steps in a project.
- Planning of lifts and routes for carrying (limited).
- Limited planning of approach to projects.
- Limited flexibility of break selection.
- Tool selection.
- Mode of transportation around site.

Accommodative Considerations

1. Individual with spine related problems may have difficulty with the twisted, crouched and stooped postures as well as with lifting and carrying activities.
2. Upper extremity problems including the hand, wrist and elbow would be difficult to accommodate because of constant gripping and tool manipulation with high force (especially in awkward postures).
3. Shoulder injuries may also be aggravated by the heavy tool use and the sustained elevated arm postures inherent in the job.
4. Individuals recovering from systemic illness should be carefully screened before entering this activity because of potential to be alone and/or working on ladders.
5. Individuals who do not cope well in outdoor work environments or confined spaces would have difficulty with this position.
6. There is a long learning curve associated with the job that includes formal training and certification.



Summary of Stresses

Metabolic Stresses

These stresses can be highly variable with the majority of power being supplied through the aerobic energy system in reasonably fit individuals. Duties such as walking, sitting, crouching and kneeling would predominantly draw energy from this system. More concentrated activity like stair climbing (which can be common) will challenge the aerobic system more. Many activities require high levels of force production from a variety of muscle groups to pull on wrenches, to lift and move parts or to climb ladders. The power for these requirements would be primarily derived from the anaerobic metabolism and can be drawn upon frequently through the day for brief (usually less than 45 seconds) periods of time. The maximum energy demand is in the order of 6 METs (21 ml/kg/min).

Structural Stresses

There are a number of high risk exposures to the physical structures of the body in this job. Some are related to movement and some are related to postures.

Spine

There is obvious exposure to most of the spine, but more specifically to the lumbar and thoracic regions. This exposure can come from several different possibilities. The first is high anterior disc compression from flexed postures that can include supporting high loads great distances from the body in awkward locations. The second possibility is that of prolonged strain on the spinal ligaments from working in a kneeling position. This increases instability of the structures over time. A third possibility is a sudden shearing force when lifting or moving a heavy object or when a wrench pops free. The last aspect is rotating/twisting motions which can occur in combination with the previous factors. This exposes the facet joints of the spine to damage as well as weakening the disc fibre integrity. If proper lifting technique is observed when lifting is required in comfortable spaces, the risk to the spine will be minimal even if the loads are high. There is severe postural stress in carrying the toolbox which can weigh up to 35 kilograms. Since it is a one arm carry, the opposite side of the body is forced to compensate for the uneven loading, placing severe lateral compression on the spine and possibly interfering with normal neuromuscular spinal control if it occurs frequently enough.

Shoulder and Upper Extremity

The shoulder joint has to contend with sustained flexed and abducted postures (overhead often) under occasionally high load. The result is considerable joint



instability with high joint compression and ligament strain in addition to probable temporary supraspinatus impingement from time to time.

Forearm and Wrist

The muscles of the forearm and wrist are required to produce frequent and often constant moderate to maximal grip forces. This combined with the often pronated or deviated position of the joint can lead to carpal tunnel stress and tendinitis previous to that. The elbows would be at particularly high risk of developing epicondylitis from the constant mechanical strain on the muscles and tendons that originate there. This is because of the awkward positioning encountered that prevents high force development from the large muscles of the hip, back and chest forcing the majority of the force development onto the ill-equipped forearm structures.

Neck

Extended neck postures in conjunction with elevated arm positions load the neck musculature significantly while also jamming the joint surfaces in the cervical spine together.

Knee and Ankle

The knee absorbs considerable compressive stress in kneeling and crouching postures. Kneeling can place high loads against the patella (kneecap) when it is unsupported and the knee joint is 'open'. Crouching loads the ligaments in the joint past the critical stress limits of the connective tissue and can contribute to increased joint laxity over time. Anterior knee pain and the development of patello-femoral syndrome are likely in these individuals. Arthritic changes can also be expected in most workers.

The ankle joint is required to stabilize the body in balanced positions on ladders and pipes and in all joint directions. It is particularly vulnerable on the lateral aspect to sudden inversion of the foot on uneven surfaces.

INTERVENTIONS

Recommendations that could be implemented to increase productivity and lessen the risk of injury are listed below:

1. Every effort should be made to provide tools that are light and easy to use because of the awkward positions frequently encountered in the job. In addition care



should be taken to improve grip sizes to as close to individual optimal sizes to maximize force transfer and reduce forearm flexor strain.

2. Mechanical assists should be utilized wherever possible to reduce dangerous loading in awkward spaces. Continued education in rigging techniques is vital.
3. Educate employees relative to creative movement technique to help limit exposures to unmanageable physiological stress.
4. Undertake projects in an order that will limit awkward access to components. This may involve removing obstructing components if that is reasonable.
5. Splitting tools across two boxes would balance the load on the spine substantially when carrying the toolbox(es). One in each hand.
6. Providing a small dolly will be helpful in transporting tools over large distances.
7. Provide gloves that offer the required protection with minimal interference in sensation.
8. Pipestands should be adjustable in height to optimize force transfer and total body position.
9. Knee pads should be provided to all workers to reduce heating and compression of the knee joint.
10. Active whole body conditioning would be the best protection against injury as the nature of the job places many unmanageable stresses on many structures. Ensuring that the tissue is strong and flexible and that energy delivery is efficient would be a critical recommendation.
11. The final recommendation involves moving from the sedentary activities of sitting or standing to a labour intensive task. Time should be taken to put the muscles and joints of the torso, hip and shoulder region through a full range of motion and to increase muscle and joint temperatures. This insures adequate preparation of body structures to effectively and safely participate in the required activities.

PJDC-WWTP Pipefitter

Referral: Mike Arcand		Organization: GVRD						Title: WWTP Pipefitter		
Dept.: WWTP		Division: WWTP						Contact: Mike Arcand		
PHYSICAL DEMANDS		REQD	SIDE	FREQUENCY*				Max. Weight (kg)	Usual Weight (kg)	COMMENTS
				Sel 1	Low 2	Mod 3	High 4			
S T R E N G T H	Lifting - Floor to Knuckle	B			X			75	20	Tool kit, fittings, valve assemblies, pipe, rigging
	Lifting - Knuckle to Waist	B			X			75	10	Pipe, fittings, valve assemblies, rigging
	Lifting - Waist to Shoulder	B			X			35	5	Pipe, fittings, valve assemblies, rigging
	Lifting - Over Head	D			X			20	arm+	Fittings, rigging equipment and tools
	Carrying - With Handles	B			X			30	30	Toolbox (one arm) < 10 metres
	Carrying - Without Handles	D			X			35	5	Parts < 10 metres
	Pushing - Upper Extremity	B				X		55	20	Wrenches and tools, chains on rigging
	Pushing - Hip/Leg Assist	B			X			100	20	Wrenches, pipe (some suspended)
	Pulling - Upper Extremity	B				X		55	20	Wrenches, parts, comealong
	Pulling - Hip/Leg Assist	B			X			100	40	Chain on come-along or on wrenches
	Reach - Shoulder or Above	B		X				arm +	arm +	Overhead repairs and installations, can sustain
	Reach - Sho. or Above extnd	B		X				arm +	arm+	Sustained in awkward locations
	Reach - Below Shoulder	B				X		35	arm+	Accessing tools, work on connections
	Reach - Bel. Shoulder extnd	B			X			35	low	Reaching around large equipment
	E N R G	Handling	B			X		max.	mod	Tools, parts, pipe, hoses
Gripping		B				X	max.	high	Turn/hold pipe, tools (esp. wrenches), parts	
Fine Finger Movements		B			X		high	low	Small bolts/nuts, cleaning +adjustment	
P O S T U R E +	Aerobic (percent)						70		Walking, light climbing, standing, low level tool work	
	Anaerobic (percent)				30				Full body exertion in lifting, pull/pushing, climbing	
	High Energy Expenditure				X				Occasional full body activity	
	Low Energy Expenditure			X					Walking, desk/bench work, travelling	
M O B I L I T Y	Neck - Static Flexion					X			Tasks below chest level (sustained for several minutes/time)	
	Neck - Static Neutral					X			While walking, standing	
	Neck - Static Extension			X					Can be prolonged when working overhead	
	Neck - Rotation	B				X			Normal movement, see around objects, not static	
	Throwing	D		X					Chains or cables over pipes for rigging (< 5 m)	
	Sitting			X					Infrequent, when travelling, on break or desk work	
	Standing					X			Almost always and on concrete surfaces	
	Walking					X			Almost always over concrete, grass, metal pipes	
	Running/Jumping			X					On/off ladders (< 1m)	
	Climbing - Arms and Legs			X					Ladders and scaffolding	
	Climbing - Legs Only					X			Stairs (up to six flights) and step up onto raised areas	
	Bending/Stooping					X			Working on many tasks in shop and plant	
	Crouching					X			Many tasks are close to ground level	
	Kneeling			X					Tasks at ground level, prolonged at times	
	Crawling		X						Into and out of confined spaces, access awkward fittings	
G E N	Twisting			X					Working around some awkward spaces, in/out con. space	
	Balancing			X					On ladders and pipes	
	Traveling			X					Around plant in cart, truck, bike, occ. Offsite in half ton	
G E N	Work Alone				X				Dependent on job , it is probable - radio contact	
	Interact with Public		X						Rare except on tours or driving off-site	
	Operate Equip/Machinery				X				Valves, pipecutter, welding equip., rigging, SCBA	
	Irregular/Extended Hours		X						In emergencies	

* Frequency Legend 1 = Seldom; Not Daily 2 = Low Daily Activity; < 1hr
 3 = Moderate Demand; Repetition 1 - 3 hrs daily 4 = High Frequency Demand; Repetition > 3 hrs daily

The following shading denotes a HIGH RISK TASK: [shaded box] Modifications should be considered

REQD is marked with an X if the particular demand or category is relevant to the purpose of the job.

SIDE refers to the side or limb required to execute a task. If it is marked **E**, it indicates either side, the most common choice is listed first. **D** refers to dominant and **B** to both sides.

PJDC-WWTP Pipefitter

Referral:		Organization:		Title: see 1st page header				
Dept.:		Division:		Contact:				
PHYSICAL DEMANDS		REQD	SIDE	FREQUENCY*				COMMENTS
				Sel. 1	Low 2	Mod. 3	High 4	
PERCEPTION	Hearing - Conversations		B			X		Communicating with co-workers
	Hearing - Other Sounds		B				X	Pumps, motors, alarms etc
	Vision - Far						X	Most tasks
	Vision - Near					X		Small, detailed adjustments, check threading/condition of pipe
	Vision - Colour						X	Pipes, wiring are colour coded
	Vision - Depth						X	Judging distance, often in poorly lit areas
	Perception - Spatial						X	Need to understand relative object position in 3 dimensions
	Perception - Form					X		Differentiate between threads or fittings with small differences
	Feeling (Tactile)				X			Detect leaks (gas/liquid), work with parts out of view
	Reading				X			Work orders, signs
WORK ENVIRONMENT	Writing			X				Minor notations and reporting
	Speech					X		Communicating with co-workers
	Inside Work						X	Buildings, tunnels, underground
	Outside Work			X				Moving between buildings, external pipe work
	Hot Conditions >25 deg. C					X		Depending on the part of the plant, varies
	Cold Conditions <10 deg.C			X				Outside work during winter
	Humid			X				Occasionally
	Dust				X			Plant is very clean, just in some confined areas
	Vapor Fumes					X		Exhaust, sewage (H2S,Meth.)
	Hazardous Machines					X		Pumps, motors, crane, fans, mechanical skimmers etc.
PSYCH	Proximity to Moving Object			X				Forklift, floor scrubber, overhead crane, trucks, bikes
	Noise					X		Varies to above 110Db (protection required)
	Electrical Hazard				X			Working around sheilded high voltage cabling
	Sharp Tools				X			Cutting tools, exposed metal and fragments
	Radiant/Thermal Energy						X	Motors, pipes, pumps, welding equip.
	Slippery Conditions					X		Working in wet areas, near leaks, in rain/snow etc.
	Vibration and Related			X				Hose, hammer, pipecutter
	Chemical Irritants					X		Cleaners, pipe dope
	Organic Substances						X	Raw or partially processed sewage
	Medical Waste			X				Possible at headworks
PSYCH	Blood Products			X				Unlikely, although technically possible
	Congested Worksite					X		Many confined areas - training req'd
	Lighting - Direct						X	Overhead incandescent, daylight
	Lighting - Indirect						X	Reflected light
PSYCH	Consequences of Error						X	High, ranging from noxious odour release to explosion/others
	Competence Challenge				X			Unique circumstances for routing pipe
	Autonomy						X	Considerable local and global authority about task execution
PSYCH	Relatedness			X				Limited team work required, have to get along with co-workers

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 For detailed descriptions of each of the different categories, please refer to the reference guide or inquire with Human Effort at 1-888-4EFFORT