

Professional Diving Services

Part of the Professional Divers Group

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Dangers of Delta P (Differential Pressure) In Diving

Diving hazards caused by differential pressure happen when water moves from an area of high pressure to an area of lower pressure. There is no risk when there is no water flow, but once the flow starts, the forces exerted are usually very substantial.

There are numerous situations where water flow occurs, this can be due to the opening of a valve, cutting into a void, or a pump starting. When the flow passes through an opening, any diver approaching the high-pressure side may be drawn in and trapped. Serious or lethal injuries often occur in such conditions.

The difference in height between two water bodies at different levels generates a suction force through any hole or opening in the barrier between them. The greater the difference in height or the bigger the opening in the barrier, the larger and more dangerous is the suction force. However, very substantial suction forces can also be created when there is a small difference in water levels and there is a relatively large opening, this can be lethal even at low depths of 3 meters.

Adequate risk assessment procedures must be carried out before diving operations start. Additionally, all isolations and tag out procedures must be put in place.

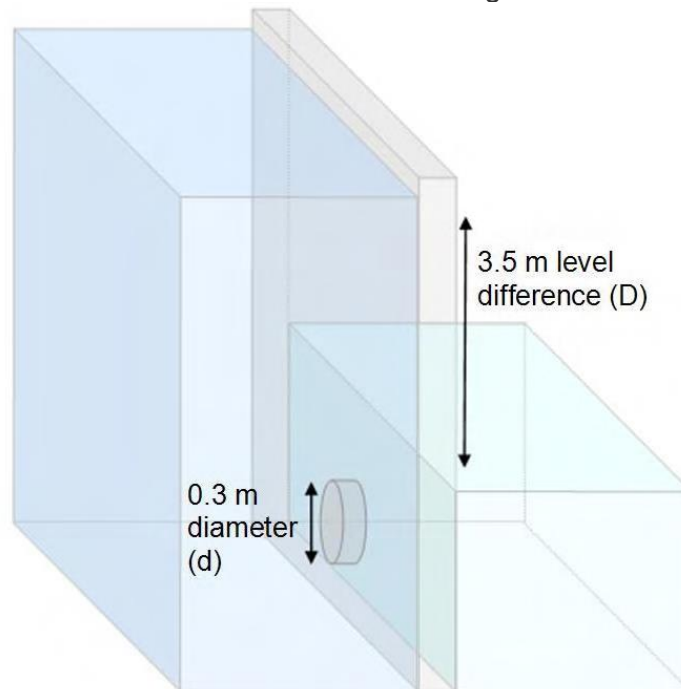
Extra care should always be taken around:

- Pumps, intakes, valves and drains.
- Dams, locks, gates and weirs.
- Cracks/ voids in pipes or hoses.
- Propellers, thrusters, on and around vessels.
- Large underwater moving equipment.
- Risk of failure of plant or machinery.
- Submerged pipes or empty structures sealed at atmospheric pressure or pressures that are higher or lower than the surrounding water pressure.

Calculating force due to differential pressure

$$\text{Force} = \text{Pressure} \times \text{Area}$$

This example calculates the force exerted on an object blocking a 0.3m diameter pipe joining two bodies of water at different levels with a height difference of 3.5m.



$$\text{Force (kilogram force)} = \text{Difference in levels} \times \text{Water Density} \times \text{Area}$$

Water Density = 1025 kg/m³ for sea water
or = 1000 kg/m³ for fresh water

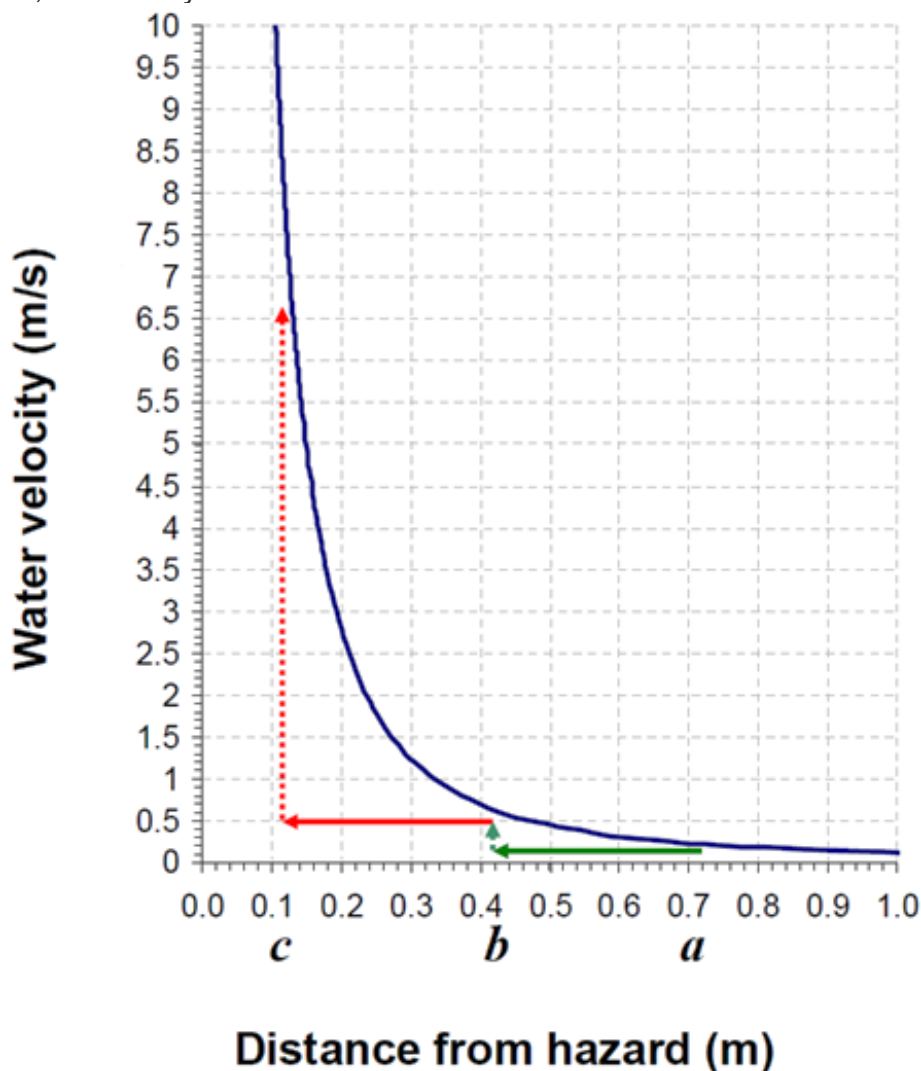
$$\text{Area} = \pi \times (\text{Diameter}/2)^2$$

$$\text{Force} = 3.5 \times 1025 \times \pi \times (0.3/2)^2 = \mathbf{254 \text{ kgf}}$$



Water velocity relationship to distance from hazard

Divers are at risk from water flow, suction or turbulence. The area of fast-moving water around these inlets (whether produced by the operation or failure of plant and machinery) is called the Differential Pressure Danger Zone (DPDZ). Divers usually cannot detect the presence of differential pressure hazards around them when submerged in the water and once they do, it's already too late.



As shown in the figure above, a diver who is moving from point **a** to **b** will not feel the change in the water flow rate but when moving the same distance, 300mm, from **b** to **c** the diver would experience an exponentially large increase in the flow rate velocity and be pulled in.

Divers should not operate in water currents exceeding **0.5 m/s**.

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Differential pressure force through a pipe (kgf)

Pipe Diameter (mm)	80	100	150	200	300	450	600	750	1000	1250
Pipe Diameter (m)	0.08	0.10	0.15	0.20	0.30	0.45	0.60	0.75	1.00	1.25
Area of Cross-section (m ²)	0.005	0.008	0.018	0.031	0.071	0.159	0.283	0.442	0.785	1.227
Depth (m)	0.5	3	4	9	16	36				
	1.0	5	8	18	32					
	1.5	8	12	27	48					
	2.0	10	16	36						
	3.0	15	24							
	5.0	26	40							
	10									
	15									
	25									
	30									
	40									
	50									

	Force < 50 kgf
	Force ≥ 50 kgf < 200 kgf
	Force ≥ 200 kgf < 350 kgf
	Force ≥ 350 kgf

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Velocity of water flow through a pipe (m/s)

Pipe Diameter (mm)	80	100	150	200	300	450	600	750	1000	1250
Pipe Diameter (m)	0.08	0.10	0.15	0.20	0.30	0.45	0.60	0.75	1.00	1.25
Area of Cross-section (m ²)	0.005	0.008	0.018	0.031	0.071	0.159	0.283	0.442	0.785	1.227
Depth (m)	0.5	0.02	0.02	0.06	0.10	0.22	0.50			
	1.0	0.02	0.03	0.08	0.14	0.31	0.70			
	1.5	0.03	0.04	0.10	0.17	0.38				
	2.0	0.03	0.05	0.11	0.20	0.44				
	3.0	0.04	0.06	0.14	0.24	0.54				
	5.0	0.05	0.08	0.18	0.31	0.70				
	10	0.07	0.11	0.25	0.44					
	15	0.09	0.13	0.30	0.54					
	25	0.11	0.17	0.39	0.70					
	30	0.12	0.19	0.43	0.76					
	40	0.14	0.22	0.50						
	50	0.16	0.25	0.55						

	Flow > 0.50 m ³ /s
	Flow ≥ 0.85 < 3.35 m ³ /s
	Flow ≥ 3.35 < 13.45 m ³ /s
	Flow ≥ 13.45 < 29.0 m ³ /s
	Flow ≥ 29.0 m ³ /s