Guardian™

# Safety manual









A guideline for the installation, handling,
& removal of pneumatic pipe plugs

## NOTICE TO EMPLOYERS, CONTRACTORS AND USERS

All personnel who use, or work in close proximity, to BurrowTech pneumatic pipe plugs must be instructed and become familiar with proper installation, handling, and removal procedures .

BurrowTech pneumatic pipe plugs are designed and manufactured with a firm commitment to quality and safety. We have strived to produce and provide the best quality plug available. However we cannot control or predict the unlimited workplace variables that can affect safety conditions. General safety conditions are overwhelmingly the result of workers adhering to and utilizing proper safety practices. NOTE: Natural rubber plugs are not for use in oil, gas, or petroleum applications.

UNDERSTAND THAT EVERY JOB IS DIFFERENT and must be carefully examined to ensure the safest procedure possible for each circumstance encountered. The safest plug on earth will still not save you if it is handled improperly or if safety practises are ignored.



### Warning

This safety manual is provided as a general guideline only. It is the user's responsibility to comply with New Zealand or Australian safety standards as they pertain to the geographical location, or job situation.

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## Before you begin

1. CHECK YOUR TOOLS: As with any repair and maintenance procedure, it is important to use ONLY the proper tools designed for your task: and know how to use them correctly. Inspect your tools closely to ensure they are in proper working condition.

Maintaining consistent and accurate air pressure is extremely important when working with plugs. Be sure that your pressure gauges are calibrated accurately and are capable of holding a steady pressure setting.

FAILURE TO MAINTAIN CONSISTANT AIR PRESSURE CAN RESULT IN PLUG FAILURE RESULTING IN POSSIBLE INJURY OR DEATH.

Also be sure that you are utilizing the tools or equipment required by New Zealand or Australian safety standards as they pertain to the geographical location, or job situation.

2. EVALUATE THE JOB: individual and unique characteristics of the working environment can greatly influence the proper repair procedure and affect the performance and equipment.



It is the supervisor's responsibility to examine each situation to determine proper repair and safety procedures. In addition, the supervisor must be aware of any New Zealand or Australian safety standards to ensure worker or public safety. It is extremely important to allow only experienced personnel to function in this decision-making capacity. Provide close supervision for individuals considered to be "assistants" or who are "in training".

FAILURE TO RECOGNIZE INHERENT DANGERS AT THE JOBSITE CAN BE DEADLY.

IF ANYONE IS UNSURE OF ANY ASPECT REGARDING SAFTEY – DO NOT PROCEED! Consult your supervisor, safety engineer, or governing authority for proper instruction.

3. SECURE THE JOBSITE. Exclude pedestrian and vehicle traffic as necessary by using traffic cones or provide other security measures as outlined by local ordinance or as required by governing authorities to ensure worker and public safety.

Do not allow unauthorized or untrained individuals inside the work perimeter. This is for their safety and yours.

## Inspecting the work area

4. TEST THE ATMOSPHERE: The work area may contain toxic of flammable gases or be oxygen deficient. It is important to ventilate confined areas such as manholes before allowing anyone to enter the work area. Always ventilate a manhole starting from the bottom. Noxious gasses are usually heavier than air and will be found in greater concentrations lower down. REMEMBER Always reinstall ventilation hoses after lowering workers into the manhole.

5. USE PROPER ENTRY PROCEDURES AND NEVER WORK ALONE. When entering confined space workspaces, ensure that the line tender utilises the proper harnesses, ropes gloves, and other appropriate safety equipment.

6. CLEAN THE PIPE: BurrowTech plugs are designed to be used in clean, dry pipes ONLY! It is important to remove any debris from the area within the pipe to ensure a proper seal. Failure to clear the pipeline of debris will cause the plug to slip and fail, resulting in possible injury or death.

7. INSPECT THE PIPE: Inspect the pipeline for evidence of damage, cracks, or breaks. Plug pressure applied to a damaged pipe can further damage the pipe causing failure of both pipe and plug.



# Making necessary calculations



8. A. MEASURE THE DIAMETER OF THE PIPE. Carefully measure the inside of the pipe you will be working with to determine its diameter. Measure the dimension in inches.

8. B. DETERMINE THE BACKPRESSURE: (Air or Liquid)
The pressure that a plug must withstand are measured in PSI (Pounds per Square Inch.) These pressures can be calculated by determining the height of the water that accumulates (head feet) from the centreline of the pipe.

8. C. DETERMINE THE PIPE'S AREA: (square inches)
R x R x 3.14.

- Divide the pipes diameter by 2 to get to radius.
- Multiply the radius by the radius.
- Multiply that number by 3.14. the resulting total will be the pipes total square inches.

EXAMPLE
Step (1) 60" Pipe diameter divided by 2 = 30"
Step (2) 30" x 30" = 900"
Step (3) 900" x 3.14 = 2826 total square inches

8. D. CALCULATE THE TOTAL POUNDS OF FORCE THE PLUG MUST WITHSTAND
Multiply the total PSI by the total square inches of the pipe. The resulting total will give you the total pounds force the plug must withstand.

EXAMPLE
10 ft of water = 4.33 PSI
4.33 PSI x 2826 Sq.in = 12,236.58 pounds of force

# Back pressure chart

HEAD FEET OF WATER TO POUNDS PER SQUARE INCH (PSI) CONVERSION TABLE

| Head Feet | PSI |
|---|---|
| 1 | 0.43 |
| 2 | 0.87 |
| 3 | 1.30 |
| 4 | 1.73 |
| 5 | 2.16 |
| 6 | 2.60 |
| 7 | 3.03 |
| 8 | 3.46 |
| 9 | 3.90 |
| 10 | 4.33 |
| 11 | 4.73 |
| 12 | 5.20 |
| 13 | 5.63 |
| 14 | 6.06 |
| 15 | 6.49 |
| 16 | 6.93 |
| 17 | 7.36 |
| 18 | 7.79 |
| 19 | 8.23 |

| Head Feet | PSI |
|---|---|
| 20 | 8.66 |
| 21 | 9.09 |
| 22 | 9.53 |
| 23 | 9.96 |
| 24 | 10.39 |
| 25 | 10.82 |
| 26 | 11.26 |
| 27 | 11.69 |
| 28 | 12.12 |
| 29 | 12.66 |
| 30 | 12.99 |
| 31 | 13.42 |
| 32 | 13.86 |
| 33 | 14.29 |
| 34 | 14.72 |
| 35 | 15.15 |
| 36 | 15.53 |
| 37 | 16.02 |
| 38 | 16.45 |

FOLLOW THE CHART BELOW TO DETERMINE THE BACK PRESSURE: ALWAYS CALCULATE MAXIMUM HEIGHT OF WATER THAT MAY ACCUMULATE

HEAD FEET OF WATER TO POUNDS PER SQUARE INCH (PSI) CONVERSION TABLE

| Head Feet | PSI |
|---|---|
| 39 | 16.89 |
| 40 | 17.32 |
| 41 | 17.75 |
| 42 | 18.19 |
| 43 | 18.62 |
| 44 | 19.05 |
| 45 | 19.48 |
| 46 | 19.92 |
| 47 | 20.35 |
| 48 | 20.78 |
| 49 | 21.22 |
| 50 | 21.65 |
| 51 | 22.08 |
| 52 | 22.52 |
| 53 | 22.95 |
| 54 | 23.18 |
| 56 | 23.82 |
| 55 | 24.25 |
| 57 | 24.68 |

| Head Feet | PSI |
|---|---|
| 58 | 25.11 |
| 59 | 25.55 |
| 60 | 25.96 |
| 61 | 26.31 |
| 62 | 26.85 |
| 63 | 27.28 |
| 64 | 27.71 |
| 65 | 28.14 |
| 66 | 28.58 |
| 67 | 29.01 |
| 68 | 29.44 |
| 69 | 29.88 |
| 70 | 30.31 |
| 71 | 30.74 |
| 72 | 31.18 |
| 73 | 31.61 |
| 74 | 32.04 |
| 75 | 32.47 |

# Inspection of pneumatic plugs

Now that you have calculated (1) THE TOTAL BACK PRESSURE being exerted, (2) THE TOTAL PIPE AREA in square inches (3) THE TOTAL POUNDS OF FORCE the plug must back, you are now ready to select the correct BurrowTech plug to suit your job application.

9. SELECT THE PROPER PLUG: BurrowTech plugs are clearly marked with minimum and maximum usage ranges. Select the proper plug for your particular job application. Select an air hose that is long enough to place you OUTSIDE OF THE DANGER ZONE! During plug inflation and use.

WARNING: DO NOT INSTALL A PLUG WHERE THE PRESSURES AND FORCES EXCEED THE MAXIMUM RATING LISTED ON THE PLUG. IF YOU DO NOT HAVE THE RIGHT PLUG FOR YOUR SPECIFICATION - DO NOT PROCEED, USING THE WRONG PLUG OR OVERINFLATING A PLUG TO COMPENSATE FOR EXSERTED PRESSURES CAN RESULT IN PLUG FAILURE, PIPE DAMAGE, INJURY, OR DEATH.



10. INSPECT THE PLUG: ALWAYS inspect the plug for damage before putting into service. IF A PLUG LOOKS QUESTIONABLE - DO NOT USE IT! Damage may consist of, but is not limited to, bulges, cuts, and abrasions, loose or distorted fittings, or apparent bond releases.

IMPORTANT: MARK DAMAGED OR QUESTIONABLE PLUGS WITH BRIGHTLY COLOURED PAINT AND TAG FOR REPAIR OR DISPOSAL AND SET ASIDE IN A SEPARATE LOCATION.

FAILURE TO CAREFULLY INSPECT EACH PLUG BEFORE USE COULD BRING DIRE CONSEQUENCES – PROPERTY DAMAGE, INJURY OR DEATH

11. CLEAN THE PIPE: After carefully inspecting the plug for damage, clean with detergent and water. Allow the plug to thoroughly dry before use. Repeat this cleaning procedure after each use.

NEVER USE SOLVENTS OR PETROLEUM PRODUCTS TO CLEAN PLUGS. The plugs' composition and bonding materials used in their construction may be severely weakened resulting in catastrophic failure of the plug.

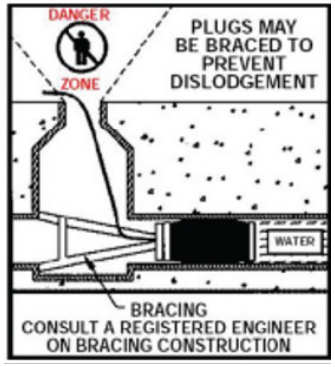


## Installation of pneumatic plugs

12. INSTALL BRACING AND BACK - UP SYSTEM: Tremendous and potentially deadly forces are present when plugging a pipeline. It is therefore ABSOLUTELY ESSENTIAL that you provide bracing for the plug to ensure your safety in the event of an accidental dislodge. This block or brace should be designed to contain a dislodged plug, and all materials behind it, should the plug fail during use.

CONSULT A REGISTERED ENGINEER FOR PROPER DESIGN AND CONSTRUCTION OF SUCH A BRACE

Additional back up plugs, placed upstream from your main plug, may be used to prevent leakage and reduce the pressures on the main plug.




NEVER RELY SOLELY ON A SINGLE PLUG TO PREVENT PROPERTY DAMAGE OR LEAKAGE, ALWAYS PROVIDE A BACK-UP SYSTEM.

13. WARNING! ALWAYS AVOID THE DANGER ZONE!




This is the area directly in front of the pipeline and plug. It is an invisible funnel shaped zone, increasing in size as it moves outwards from the plug. It is essentially a blast area, acting much like the explosion of launching a projectile from a cannon. Should the plug fail, the plug and accompanying debris will launch outward with tremendous and deadly force. Surrounding obstacles may also deflect flying debris. This ricocheting factor adds a further unpredictable element to an already dangerous plug failure.

14. ATTACH THE INFLATION AIR LINE & ROPES – USE CAUTION! Improper attachment of inflation hose may cause the plug to deflate unexpectedly resulting in plug failure.

15. LOWER THE PLUG INTO THE PIPE CAREFULLY. Metal eyebolts are provided for handling the plug.

NEVER USE THE EYEBOLTS TO SECURE A SAFTEY ROPE OR AS A MEANS TO RESTRAIN THE PLUG DURING DEFLATION. THESE ITEMS ARE NOT DESIGNED TO WITHSTAND THE PRESSURES AND FORCES INVOLVED.

16. CAREFULLY INSERT THE PLUG INTO POSITION

- Insert plug into pipeline a minimum of the diameter measurement of the pipe.
- Do not allow plug to protrude from pipeline while inflating.
- Do not insert plug over or near sharp objects or obstructions.
- Do not insert plugs where 2 pipes intersect. Plugs are designed to work by applying plug pressure evenly from the sides of the plug.

17. INFLATE THE PLUG Check the air pressure gauge, ensure that the pressure is holding steadily. PARTIALLY INFLATE PLUG. Check the air pressure at the gauge. Repeat this cycle of inflating to maximum air pressure.

- TAPE OFF THE AIR VALVE TO PREVENT ACCIDENTAL PRESSURE RELEASE.
- CONTINUE TO MONITOR THE AIR PRESSURE GAUGE, ENSURE CONSISTANT PRESSURE.
- NEVER EXCEED THE MAXIMUM PRESSURE: FAILURE OF THE PLUG WILL RESULT.
- NEVER USE AN UNDER -INFLATED PLUG. IT WILL SLIP & FAIL.
- DO NOT REMOVE OR DISABLE PRESSURE RELIEF VALVE.

# Removal of pneumatic plugs

18. REMOVAL OF PNEUMATIC PLUGS

A. DEFLATING THE PLUG. Before attempting to deflate the pneumatic plug you must release all pipe pressure. Stay out of the DANGER ZONE! Remove the tape that secures the air valve.

B. SLOWLY DECREASE THE AIR PRESSURE until the plug is COMPLETELY deflated.

a. REMOVE THE PLUG SLOWLY by pulling on the ¼ “ rope attached to the metal eyebolts provided for the purpose

b. DO NOT ATTEMPT TO PULL THE PLUG FROM A PIPELINE BEFORE THE PLUG IS COMPLETELY DEFLATED

c. DO NOT USE THE AIR INFLATION HOSE TO PULL THE DEFLATED PLUG FROM THE PIPELINE.

d. INSPECT AND CLEAN the plug before storing it away for future use.



# Factors affecting back pressure

| Product Code | | PIPE DIAMETER (mm) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25 | 50 | 70 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 | 800 | 900 | 1000 | 1200 | 1400 | 1600 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 |
| Ø25–Ø50 | 3bar working pressure | | | | | | | | | | | | | | | | | | | | | | | | |
| Ø35–Ø70 | 3bar working pressure | | 0.8 | 0.5 | | | | | | | | | | | | | | | | | | | | | |
| Ø50–Ø100 | 1.5bar working pressure | | 1.0 | 0.8 | 0.5 | | | | | | | | | | | | | | | | | | | | |
| Ø50–Ø100 | 2.5bar working pressure | | 1.5 | 1.2 | 1.0 | | | | | | | | | | | | | | | | | | | | |
| Ø70–Ø150 | 1.5bar working pressure | | | 1.0 | 0.8 | 0.5 | | | | | | | | | | | | | | | | | | | |
| Ø70–Ø150 | 2.5bar working pressure | | | 1.7 | 1.4 | 1.0 | | | | | | | | | | | | | | | | | | | |
| Ø100–Ø200 | 1.5bar working pressure | | | | 1.0 | 0.8 | 0.5 | | | | | | | | | | | | | | | | | | |
| Ø100–Ø200 | 2.5bar working pressure | | | | 1.7 | 1.4 | 1.0 | | | | | | | | | | | | | | | | | | |
| Ø150–Ø300 | 1.5bar working pressure | | | | | 1.0 | 0.8 | 0.7 | 0.5 | | | | | | | | | | | | | | | | |
| Ø150–Ø300 | 2.5bar working pressure | | | | | 1.7 | 1.5 | 1.3 | 1.0 | | | | | | | | | | | | | | | | |
| Ø200–Ø400 | 1.5bar working pressure | | | | | | 1.0 | 0.8 | 0.7 | 0.5 | 0.5 | | | | | | | | | | | | | | |
| Ø200–Ø400 | 2.5bar working pressure | | | | | | 1.7 | 1.5 | 1.3 | 1.2 | 1.0 | | | | | | | | | | | | | | |
| Ø200–Ø500 | 1.5bar working pressure | | | | | | 1.0 | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | | | | | | | | | | | | | |
| Ø200–Ø500 | 2.5bar working pressure | | | | | | 1.9 | 1.7 | 1.5 | 1.4 | 1.2 | 1.0 | | | | | | | | | | | | | |
| Ø300–Ø600 | 1.5bar working pressure | | | | | | | | 1.0 | 0.8 | 0.7 | 0.6 | 0.5 | | | | | | | | | | | | |
| Ø300–Ø600 | 2.5bar working pressure | | | | | | | | 1.5 | 1.4 | 1.3 | 1.2 | 1.0 | | | | | | | | | | | | |
| Ø500–Ø1000 | 1.5bar working pressure | | | | | | | | | | | 1.0 | 0.8 | 0.7 | 0.6 | 0.5 | | | | | | | | | |
| Ø500–Ø1000 | 2.5bar working pressure | | | | | | | | | | | 1.5 | 1.4 | 1.2 | 1.1 | 1.0 | | | | | | | | | |
| Ø500–Ø1200 | 2.5bar working pressure | | | | | | | | | | | | 1.0 | 0.8 | 0.7 | 0.6 | 0.5 | | | | | | | | |
| Ø600–Ø1200 | 2.5bar working pressure | | | | | | | | | | | | 1.0 | 0.8 | 0.7 | 0.6 | 0.5 | | | | | | | | |
| Ø600–Ø1200 | 1.5bar working pressure | | | | | | | | | | | | 1.2 | 1.0 | 0.9 | 0.8 | 0.7 | | | | | | | | |
| Ø600–Ø1600 | 1bar working pressure | | | | | | | | | | | | 1.7 | 1.5 | 1.2 | 1.0 | 0.8 | 0.5 | 0.3 | | | | | | |
| Ø600–Ø1600 | 1.5bar working pressure | | | | | | | | | | | | | 1.4 | 1.3 | 1.2 | 0.9 | 0.6 | 0.4 | | | | | | |
| Ø800–Ø1600 | 1bar working pressure | | | | | | | | | | | | | | | 1.3 | 1.0 | 0.7 | 0.5 | | | | | | |
| Ø800–Ø1800 | 1bar working pressure | | | | | | | | | | | | | | | | | 0.8 | 0.6 | 0.4 | | | | | |
| Ø800–Ø2000 | 1bar working pressure | | | | | | | | | | | | | | | | | 0.9 | 0.7 | 0.5 | 0.4 | | | | |
| Ø800–Ø2200 | 1bar working pressure | | | | | | | | | | | | | | | | | 1.0 | 0.8 | 0.6 | 0.4 | 0.3 | | | |
| Ø1200–Ø2400 | 1bar working pressure | | | | | | | | | | | | | | | | | | 0.9 | 0.8 | 0.6 | 0.5 | 0.4 | | |
| Ø1200–Ø2600 | 1bar working pressure | | | | | | | | | | | | | | | | | | | 0.7 | 0.5 | 0.5 | 0.4 | 0.3 | |
| Ø1200–Ø2800 | 1bar working pressure | | | | | | | | | | | | | | | | | | | | 0.6 | 0.6 | 0.5 | 0.4 | 0.3 |

This table is valid for dry iron pipes only

1. Temperature Effect: As the temperature increases, the air inside the plug expands, and as the air expands, the air inside the plug expands, the pressure will increase. The greater the pressure inside the plug, the more pressure there will be behind the plug. In this case, the pressure inside the plug must be carefully controlled during use. Otherwise, distortions and explosion may occur from the plug.

2. Type of Pipe Effect: One of the biggest factors that allows the plug to stay in the pipe without slipping is the friction force of the pipe on rubber. It is very important to know the pipe type in product selection. The higher the friction force, the greater the resistance of the plug to the pressure behind it.

μ: friction force

$\mu_{(concrete)} > \mu_{(iron)} > \mu_{(HDPE)}$

# Chemical resistance table

Chemical Resistance Table for Rubber Material

Type of Flow: The type of rubber used in the production of the plugs are selected according to the fluid or chemical in the pipe. There are basically different types of rubber: NR/SBR and NBR. Please review the Chemical Resistance Table for Rubber Material opposite to choose the right product.

| Chemical | Temperature (°C) | NR / SBR | NBR |
|---|---|---|---|
| Acetone | 23 | A | A |
| Acetylene | | A | A |
| Ammonium Hydroxide | 23 | C | B |
| Aniline | 23 | C | A |
| Benzene | 23 | C | A |
| Boric Acid | 100 | A | A |
| Brake Fluid | 50 | B | B |
| Butanol | 50 | A | A |
| Butyric Acid | | C | B |
| Calcium Hydroxide | 100 | A | A |
| Calcium Hypochlorite | | B | B |
| Chlorine Acid | 23 | C | B |
| Diesel Oil | | C | A |
| Alcohol | | B | B |
| Ether | 23 | C | B |
| Formuldehyde Solution 40% | | A | A |
| Glycerinde | 100 | B | B |
| Hexanole | 23 | A | A |
| Hydrogen Peroxide | 23 | A | A |
| Kerosene | 70 | C | A |
| Methanol | 50 | A | A |
| Methyl Cloride | | C | B |
| Milk | 23 | A | A |
| Petroleum (ASTM No.1, ISO 1817) | 100 | C | A |
| Petroleum (IRM 902, ISO 1817) | 100 | C | A |
| Petroleum (IRM 903, ISO 1817) | 100 | C | A |
| Naphtha | 23 | C | C |
| Naturalgus | | C | C |
| Nitric Acid | 50 | C | A |
| Ozone | 40 | C | C |
| Phenol | 100 | C | C |
| Phosphorus Acide 60% | 50 | C | B |
| Propanol | 50 | B | B |
| Sodium Hydroxide | 100 | A | A |
| Sodium Hypochlorite | 50 | B | B |
| Sulphurhexafluoride | | C | B |
| Sulphuric Acid 50% | 100 | A | A |

KEY

A: GOOD

B: MODERATE

C: NOT RECOMMENDED

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