

# Codes and standards for composite repair systems

Simon Frost - Walker Technical Resources



## Relevant standards for composite repairs

---

The relevant, applicable standards for composite repair systems are;

- ISO/TS 24817 – Composite repairs for piping.
- ASME PCC-2 Articles 4.1 and 4.2 High and low risk - Non-metallic composite repair systems for pipelines and pipework

In essence there is no significant or major difference between these two standards. Developments in one standard are mirrored in the other standard.

## Scope of the applicable standards

---

The scope of ISO/TS 24817 and ASME PCC-2 covers the following components;

- Pipelines
- Pipework including straights, elbows, tees, flanges, reducers, valve bodies
- Tanks and vessels including nozzles and attachments

The standard can also act as guidance for repairs applied to risers and structural strengthening applications

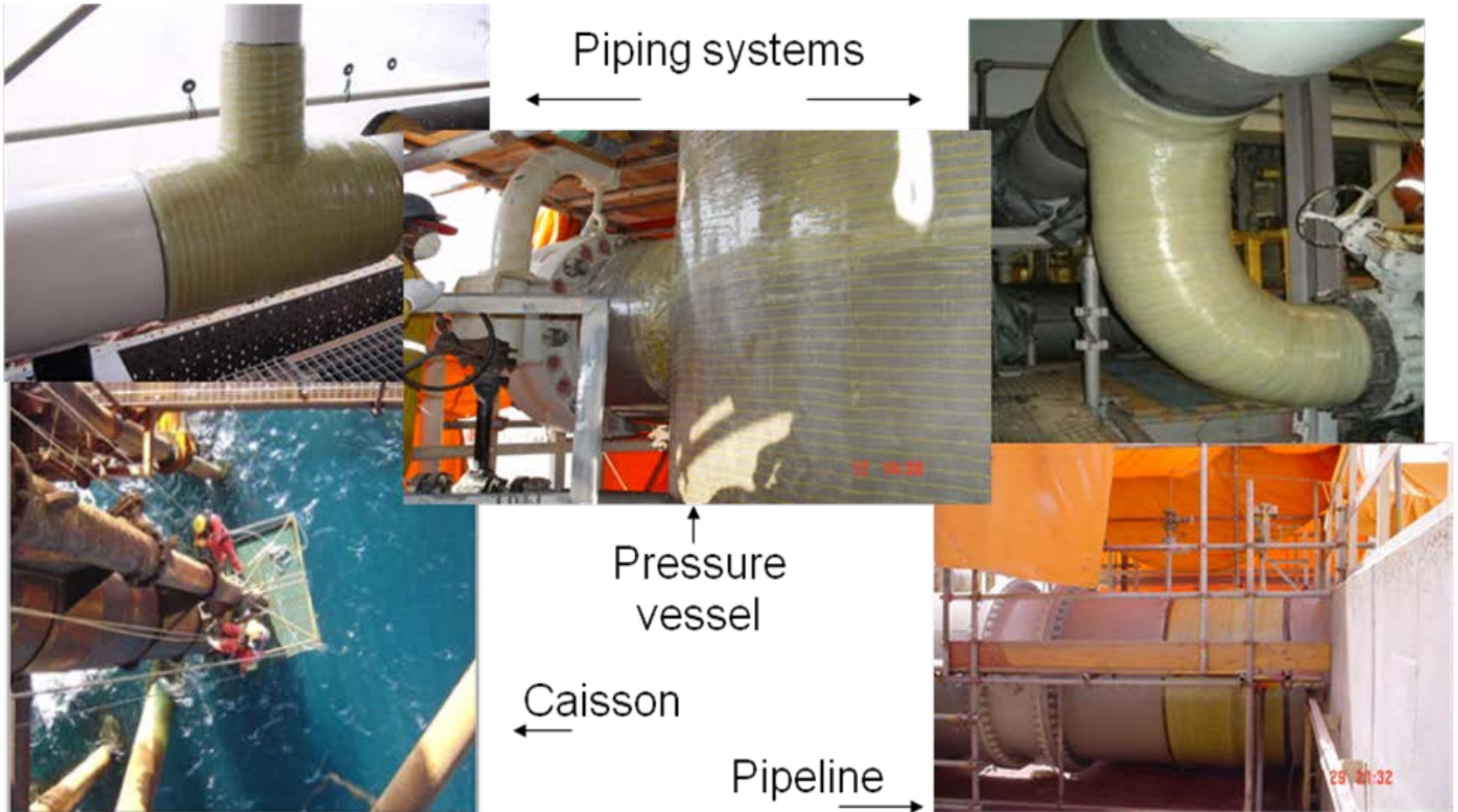
## Acceptable defect types

---

ISO/TS 24817 nor ASME PCC-2 do not define what is an acceptable defect to repair, but assumes that a decision has been made to repair a given defect, under the relevant code, e.g. B31G, API 579, ASME FFS-1 using a composite repair.

The decision of what constitutes an acceptable defect for repair is beyond the remit of both ISO/TS 24817 and ASME PCC-2.

# Where can they be used?





## Contents of the standards

The contents of ISO/TS 24817 and ASME PCC-2 includes details on;

- Qualification; tests repair suppliers are required to perform to conform to the standard
- Design; how to determine the repair thickness and extent
- Installation; guidance is provided on the critical issues e.g. surface preparation, minimum QA/QC requirements and applicator training
- Inspection; guidance on how to inspect the repair system

# Defect types

---

The two generic types of defects that are covered by ISO/TS 24817 and ASME PCC-2 are;

- Defect Type A
  - Caused by external corrosion or mechanical damage
  - Not through wall
  - Application of the repair will arrest further degradation
- Defect type B
  - Caused by Internal corrosion or erosion
  - Through wall (or will become through wall during the lifetime of the repair)
  - Degradation of the defect will continue after the repair is applied

# Defect types

---

Crack like defects are not specifically covered by ISO/TS 24817 or ASME PCC-2, however;

- If it can be demonstrated in a defect assessment procedure that the crack will not grow then a composite repair can be applied to strengthen the affected region.
- Composite repairs may be applied to surface breaking cracks where the intention is to prevent leakage.

In general the repair of crack like defects using composite repairs will not prevent further crack growth.



# Philosophy

---

- The overall philosophy of the two standards is “performance based”
- In other words no prescription in terms of materials (fibres or resin) nor minimum strengths is provided
- The repair supplier demonstrates the performance of the composite repair system through testing – both standards specify what testing should be performed
- The testing performed should replicate those procedures used in the field

# Composite repair types

- There is no restriction on the material types nor the configuration of fibres and resin
- Most composite repair systems use one of the following combination of material types;
  - Fibres – Aramid, Carbon, Glass
  - Resins – Epoxy, Polyurethane
- Construction of the repair system;
  - Wet lay-up
  - Pre-manufactured bands or coils
- All combinations of the above are considered within either standard

# Repair lifetime

- The standards do not use the terminology “temporary” or “permanent” – terms are vague
- The required lifetime of the repair is defined by the end user (on which the design of the repair is based)
- The maximum lifetime considered within either standard is 20 years
- The repair is designed for the defined lifetime implying that at the end of life the end user must either replace the repaired line or assess the status of the repair and extend its lifetime

# How to design repairs?

---

Design of a composite repair answers the following questions;

- Is the repair strong enough in all loading directions? (strength calculation)
  - Allowance for the remaining wall thickness of steel
  - Composite repair withstands the full applied load
- Will the repair remain bonded to the surface ? (adhesion strength calculations)
- Is the extent of repair sufficient to ensure load transfer between repair and substrate?

Output of design is the repair thickness and extent of repair

---

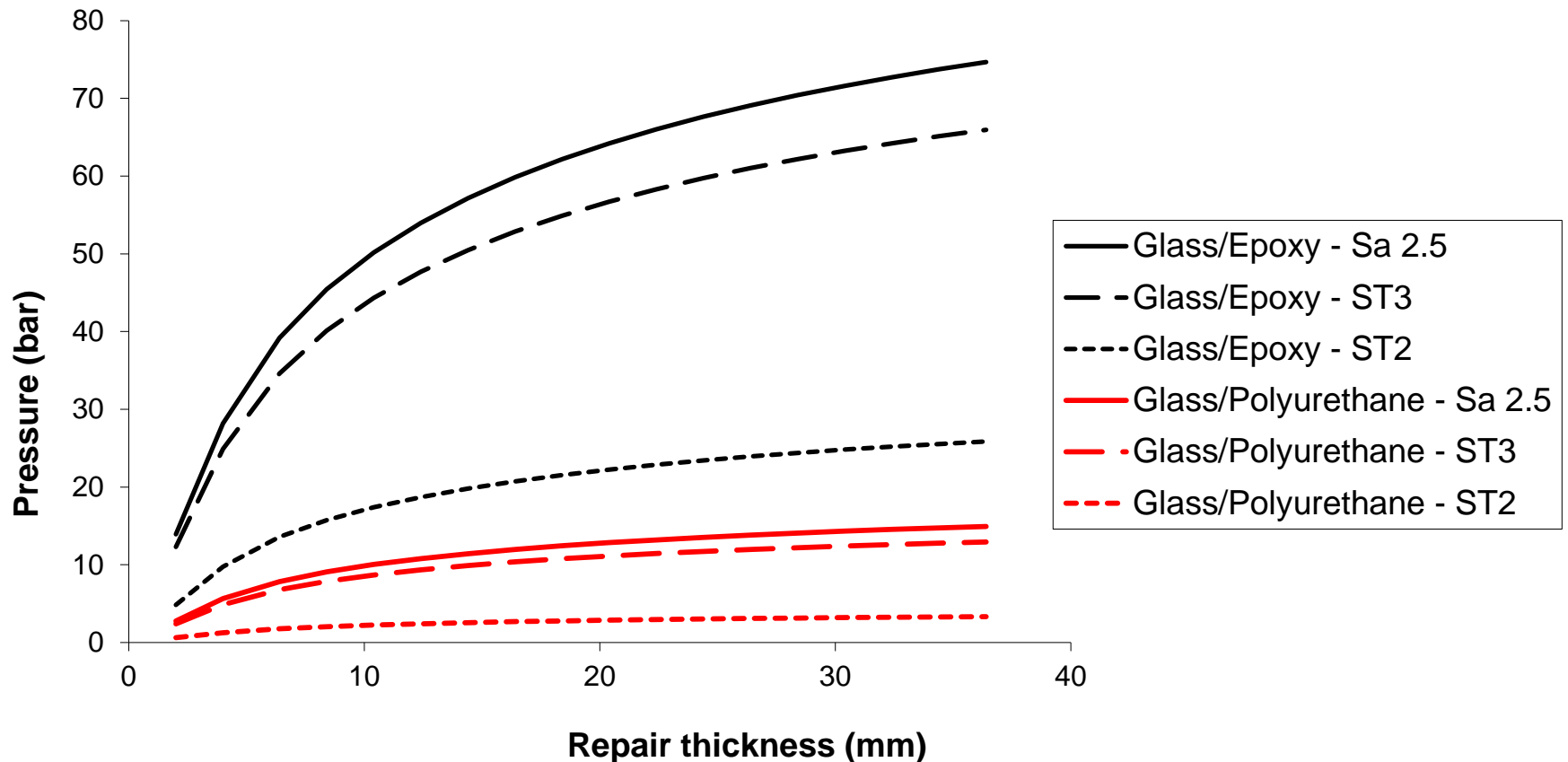
# Design considerations

---

- Base unit for design is the combined structure – Repair, surface preparation procedure and substrate
- For internal defects and through wall defects, the application of a composite repair will not stop internal corrosion. Therefore need to assume that internal defect will grow through wall during design life
- For external defects, the application of a composite repair will prevent further corrosion
- Qualification test data is used as input for the repair design

# Effect of material and surface preparation

Design pressure against repair thickness for a design lifetime of 20 years and a circular through wall defect of diameter 25 mm.

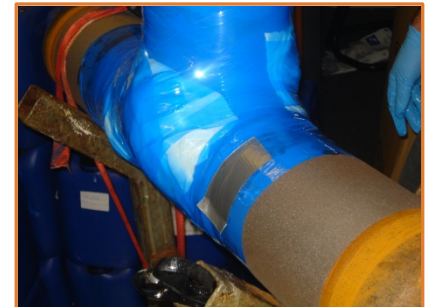




# How to install repairs?

## Most critical step in the use of composite repairs

- Get the surface preparation and other installation issues correct, if not, no matter how well designed the repair it will leak or fail!!
- Repairs should always be applied by trained, competent applicators
- QA controls should always be followed as defined in installation method statement
  - Measurement of surface roughness
  - Repair laminate lay-up
  - Measurement of cure – Barcol hardness



# Summary of inspection recommendations

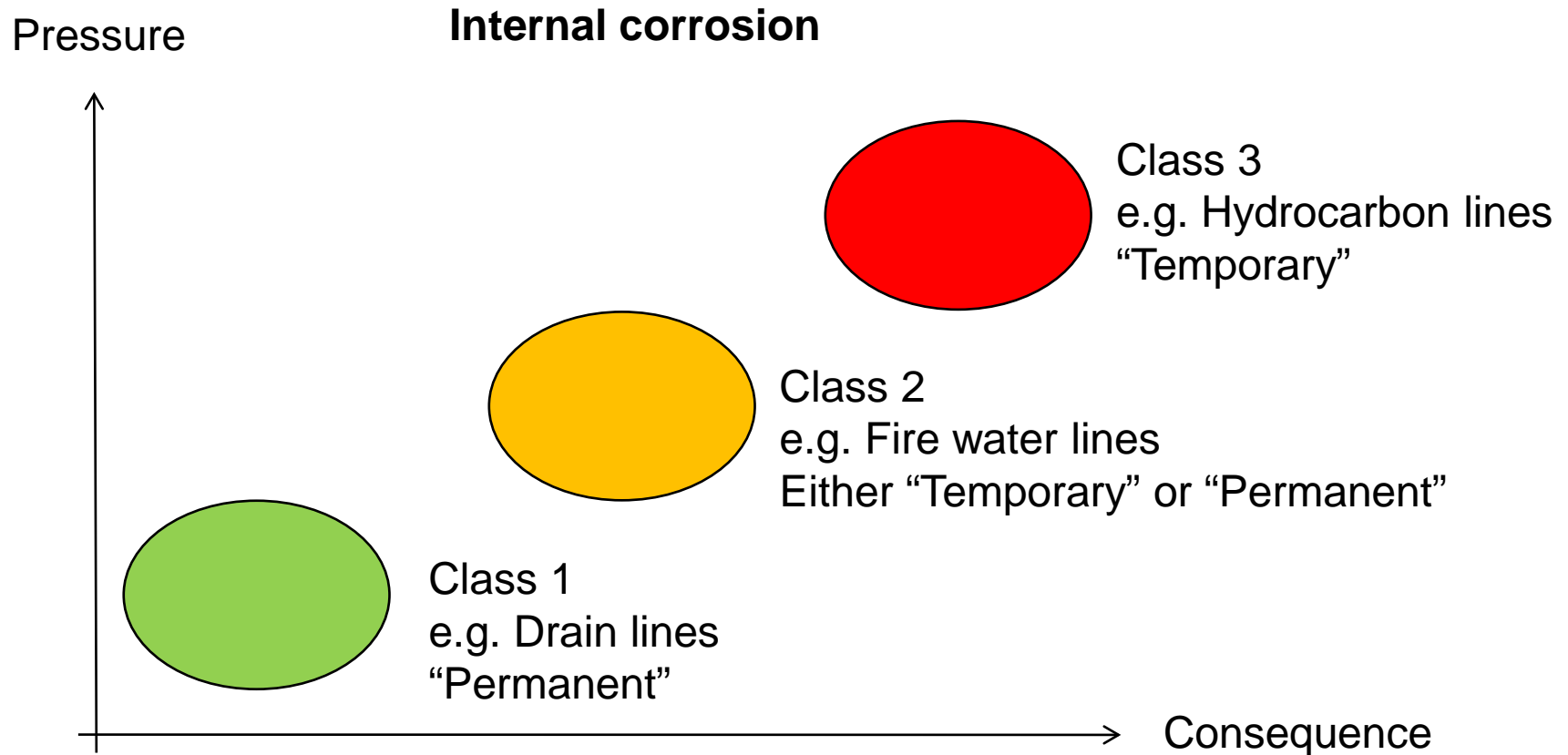
- For external defects
  - Visual inspection of repair – delamination will be initiated at the edge of repair
- For internal defects
  - Visual inspection for edge delamination and also check for discolouration
  - Radiography or Electromagnetic (with a stand-off) e.g. SLOFEC, PEC, for inspection of the steel substrate underneath the repair
  - Unable as yet to inspect reliably the interface (development trials on-going)
- Current activities
  - PRCI initiative – Inspection of composite repairs (ESR Technology, UK)

# UK HSE Perspective

- Both non safety critical and safety critical structures can be repaired in line with a risk assessment
- Specific guidance can be found in HSE OSN - 'Weldless repair of safety critical piping systems'.
- The philosophy for repair is;
  1. Replace like for like
  2. Temporary repair until replacement
  3. Permanent repair only where replacement is not practical
- Each repair should be designed on a bespoke basis and have a defined life
- The HSE do not approve as such repairs but require the management of the integrity to be demonstrated

# Repair Class – Temporary or Permanent?

**External corrosion** – for all Classes of repair – “Permanent”



# Conclusions

- Two standards, ISO/TS 24817 and ASME PCC-2 are available to ensure the composite repairs are an engineering solution
- The scope of these standards covers pipelines, piping systems, tanks and vessels
- The lifetime of a composite repair can be up to 20 years. The lifetime is defined by the end user.
- The standards are not defect assessment standards, the starting point is that a decision has been taken to use a composite repair
- The standards provide detailed design procedures and guidance on installation, training of applicators and in-service inspection

# Reactive repairs

## Overview

- Immediate integrity issue possibly resulting in loss of production
- Client requires an engineered, cost effective solution that minimises impact on production

## Why a composite solution ?

- Cost effective
- Minimal lead time – materials and applicators available at short notice
- Integrity maintained through an engineered repair solution with a defined lifetime





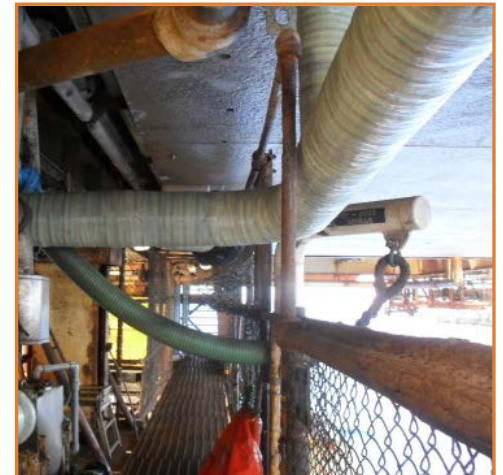
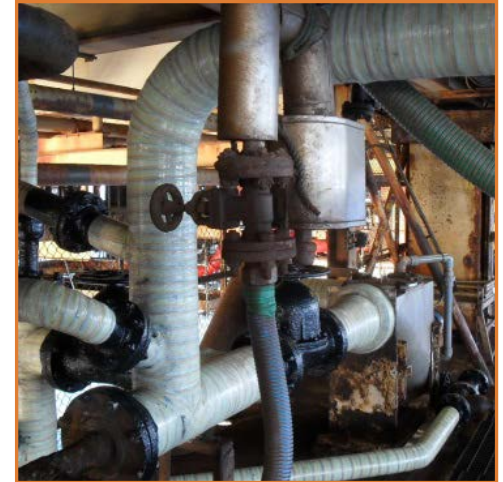
# Planned projects – Black drains

## Overview

- Four platform project to reinstate life of field integrity to black drain systems
- Up to 150 meters of composite repair per platform
- Technowrap™ composite repair solution determined by Client to be most cost effective solution

## Why a composite solution ?

- 40% saving over other options
- Overboard application through rope access
- Core crew FM team trained to assist – significantly less pressure on bed space
- Applied live – no downtime, zero impact on production
- Integrity maintained through an engineered repair solution with a life of field guarantee



# Planned projects – Pipeline repair

## Overview

- Oil transport pipeline suffering 6 o'clock internal corrosion
- Client required production to be maintained
- Technowrap™ composite repair solution determined by Client to be most cost effective solution

## Why a composite solution ?

- Applied live – no downtime and therefore zero impact on production
- Integrity maintained through an engineered repair solution with a life of field guarantee



# Caisson and riser repairs

## Overview

- Reinstatement of integrity for either internal or external corrosion
- Need to design repair for both internal pressure and axial loads

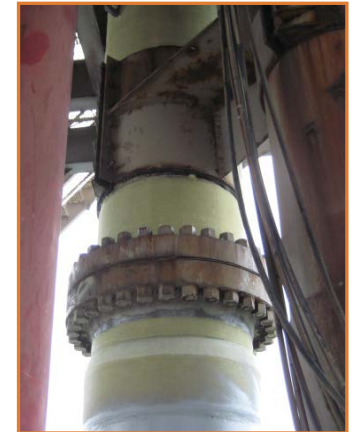
## Why a composite solution ?

- Applied live – no downtime and therefore zero impact on production
- Can be applied through rope access
- Integrity maintained through an engineered repair solution with a life of field guarantee



- Internal / external corrosion
- Pressure/Temp: 2 Bar / 15°C
- 36" sea-water caisson

- External corrosion
- Pressure/Temp: 25 Bar / 35°C
- 36" hydrocarbon riser



- External corrosion
- Pressure/Temp: 11 Bar / 38°C
- 12" closed drain

