

## Bi-Di Pig Design – Options for multi-diameter pipelines

A conventional bi-directional pig has guide discs sized below the minimum pipe internal diameter (ID) (typically 99%) and sealing discs sized above the maximum ID (typically 105%).

For example, a pig sized to suit a 24" OD x 25.4mm WT (558.8mm ID) pipeline would be sized as follows:-

Guide Disc OD = Pipe ID x 99% = 558.8mm x 99% = 553mm OD

Sealing Disc OD = Pipe ID x 105% = 558.8mm x 105% = 587mm OD



**Fig. 1 – Standard Bi-Di Pig Layout**

The term multi-diameter or dual-diameter is mostly applied to lines with definite changes in outer diameter (say 8" x 10"). This usually requires pigs similar to those in figures 1 and 2 below.



**Fig. 2 - 16" x 20" Dual-Diameter Pig**



**Fig. 3 18" x 14" Dual-Diameter**

Changes in pipe wall-thickness or fittings (valves, tees etc) can also create situations similar to those seen in true 'dual-diameter' or 'multi-diameter' pipelines. When designing a pig to suit more than one ID, we first look to see if a conventional pig design can be used. To do this we see if the sealing discs can be increased (to a maximum of 8% over the minimum line ID) or if the guide discs can be reduced. However, if the seals are too large, we run the risk of them creasing in the smallest ID, causing a leak path. Similarly, if the guide discs are too small, the pig sits lower in the large ID's, leading to a potential leak path at the top of the pig (as the seals are sitting too low in the pipe too).

If the changes in pipeline ID mean that conventional seal and guide arrangements cannot be used, then we must adopt a multi-diameter approach to the pig design. There are two basic possibilities: -

- Leave the design as normal, but cut slots around guide discs, so that they can bend easily in the smaller ID (as figure 4).



**Fig. 4 - Slotted guide pig**

- Use guide discs sized below the minimum ID, seals sized above the maximum ID and intermediate discs to provide sealing or support backup (as figure 5).



**Fig. 5 - Pig fitted with intermediate disc**

It is also possible to use a number of other techniques, such as flaps and wheel support (as figures 1 and 2), or combinations of the options above (figure 6).



**Fig. 6 - Combination design, with both slotted discs and intermediate discs**

The decision on which option to use is not based purely on the minimum and maximum pipe ID, but also where those diameters occur within the pipeline system. For example, if the line ID is the minimum ID, but bends are at the maximum, the pig will be different from one for a line where the bends are a smaller ID than the pipeline.

Propipe produces all styles of pigs, but has found that the intermediate disc design is best suited to applications where the changes in ID are significant, but not sufficient enough to be classed as fully 'dual-diameter'. The intermediate discs can be made as flexible sealing discs, thinner guiding discs (able to deflect) or a mid-hardness disc that can act as both sealing disc and guide disc.

The slotted guide arrangement is ideal for applications where the majority of the line ID is within a short range, but where short, large reductions in ID are present. It is not suited to long distance running in many applications, as the slots themselves can make the guide disc more flexible and can also lead to increased wear.

Selection of the correct pig design is always done specific to the pipeline and is dependant upon the number if ID changes and their location within the pipeline. Propipe experience and commitment to providing the correct pig is essential, to ensure safe, reliable performance.



## Example

Images below (figures 7 and 8) show pigs that were supplied to the Gulfstream Project in 2002.

These pigs were used during flooding, cleaning, dewatering and gassing-up operations for a line over 700km long (and uncoated internally).

The pipe ID range for Gulfstream was from 844.5mm to 872.7mm. The majority of the line ranged from 863mm to 877.7mm. The guide discs were sized at 855mm and it was accepted that the guides would deflect sufficiently to pass the short sections at 850.9mm and 844.6mm. Sealing discs could not be made in one size, to cover the entire ID range, so two sizes were used, at 891mm and 917mm OD's.

This design accepts that the pig will sit lower in the larger pipe ID's (because of the smaller guide discs), but compensates for this by using seals to cover the 'increased' ID range caused by the pig sitting down. If the pig had used larger, slotted guide discs, this would not have removed the need for two seal sizes, but would have added loading to the guide discs, due to their reduced rigidity and increased risk of tearing.



Fig. 7 – Front end, Gulfstream 36' pig



Fig. 8 – Overview – three pigs



Fig. 7 – Pig condition, post run