**1.1 Features of ACR**

Simple ACR devices have been available in New Zealand since the late 1970s. These devices monitor the milk flow rate from individual cows and, at a threshold, the milking vacuum is shut off and a pneumatic ram is activated to withdraw the cluster from the cow.

Most ACR use a piston and air cylinder, powered by compressed air or vacuum, to withdraw the cluster from the udder via a cord, chain or arm support connected to the claw-piece. The removal sequence is initiated by a milk flow rate sensor or by a lever mechanism. Lever types can be operated manually or by a pre-set timer in herringbone dairies. In rotary dairies, they can be activated by the rotation of the platform from one or more fixed positions.

The typical operating sequence for the common cord-type ACR is:

1. Vacuum or air pressure is applied to the air cylinder, causing the piston to move.
2. The initial movement tensions the cord and, by closing a valve in the claw or long milk tube, shuts off the milking vacuum from the cluster.
3. When vacuum in the cluster has declined sufficiently for the teat cups to start sliding down the teats, the increasing tension on the cord pulls the cluster away from the udder and swings it clear.

More sophisticated ACR include options for setting:

- or adjusting an "initial delay period" after the start of milking to avoid premature removal, especially in herds where clusters are applied before all cows have had time for milk let down (e.g. an initial delay setting of 2-3 min);
- the preferred minimum flow rate threshold;
- the "final delay time", which is a pre-determined period of 1-30 sec after a cow's milking rate has fallen below the flow rate threshold, before the cluster removal device is activated. Settings of around 3-7 seconds are suitable in smoothly operating dairies;
- a maximum milk out time for milking based on the herd yield (for example, clusters will be detached from all cows that have not activated the ACR by 7 min after the start of their milking). This feature enables the MaxT milking regimes to be implemented automatically.
1.2 Pros and cons of ACR

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Labour requirements may be substantially reduced or freed up for other jobs.</td>
<td>The milking area may become cluttered, especially in herringbone dairies.</td>
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<td>Clusters are always removed regardless of the labour in the dairy.</td>
<td>The time required to attach clusters may be marginally longer as the ACR must be activated.</td>
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<td>Milking may be quicker (not always the case).</td>
<td>ACR may be an expensive luxury item if milkers can keep up with the present number of milking units in the dairy.</td>
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<td>Clusters are removed promptly at the end of milk flow which reduces over-milking and teat damage.</td>
<td>Changes in the milking routine may be required to ensure cows are letting down prior to cup attachment.</td>
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<td>ACR detect the end of milking or low flow rate more accurately than people.</td>
<td>They add to the maintenance duties.</td>
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<td>If clusters fall off, they are quickly hung up reducing the risk of sediment in the milk.</td>
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<tr>
<td>ACR reduce milker stress and handling of clusters.</td>
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<td>Cow flow can improve due to increased cow comfort during milking.</td>
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Table 1. Advantages and disadvantages of automatic cup removers.

Labour efficiencies

Automatic cup removers will start to pay for themselves if they allow extra milking units to be installed, reduce the number of milkers required, or shorten the working day. In dairies where the milker is operating close to the maximum number of units, ACR can improve efficiency and remove a lot of stress.

When ACR are installed in rotary dairies there is an opportunity to substitute ACR for a milker as long as an automatic teat sprayer, and a method for drafting cows, are also installed. Installation of ACR in new rotary dairies is now commonplace.

Labour efficiencies from ACR are being realised more in herringbones, as dairy size increases. ACR facilitate the milking of more clusters (up to 24) per person.

While ACR can reduce the number of milkers required at each milking it is uncommon for ACR to result in a lower total head count on the farm. However, the time freed up by the ACR allows changes to the staffing roster which provides greater flexibility within the team and the opportunity for additional time off. This can make a job more attractive to potential staff. They may also lead to some reduction in the use of casual staff.

Reducing over-milking

Over-milking compromises milking speed and is a common cause of teat damage.

Milking times per cow can be shortened significantly in most New Zealand dairy herds by investing in ACR if milkers are currently operating at the top end of the number of clusters that they can handle or by using Maximum Milk Out Times (MaxT) milking regimes.
1.3 Potential challenges with implementation of ACR

Milk let down

ACR rely on a predictable milk flow pattern coming from each cow. They work best when the cups are attached to cows that have already let down their milk. Cows with variable milk flow rates due to delayed let down may have incomplete milking and poor ACR performance.

Vacuum drop across ‘attachments in the long milk tube’

Some early float-operated types of ACR sensors caused a substantial vacuum drop due to flow restrictions in milk tubes and fittings. Newer types of electronic flow sensors (i.e. conductivity sensors and infra-red) minimise this problem.

Testing the operating sequence of cord-type ACR

Most types of ACR allow some adjustment of the air or vacuum supply to the cylinder so the rate of retraction of the cord can be matched to the time when the cluster starts to slide down the teats. If the cord moves too fast, the cluster may be pulled off the teats while still under vacuum, increasing the risk of mastitis. If it moves too slowly, the cluster may fall onto the floor, increasing the likelihood of dirt getting into the system or damaging the cluster.