

ABSTRACT

Poster Paper - "MOBILE GRAIN COOLERS"

by W.B.Elder\*

Typical spoilage of bulk stored grain is shown to result from high grain temperature which subsequently leads to moisture and other problems. The many benefits of cooling are summarised. Photographs of McBea Mobile Grain Coolers in use are presented with details of the simple control panel, special features of the equipment and general operating instructions. Performance graphs relate silo and grain parameters with refrigeration system capacity factors under various climatic conditions to the effect on insect activity. An example of the use of the performance graphs is given. Other applications of the mobile coolers are suggested. A brochure describing the equipment is included in the official briefcase issued to conference participants.

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## Poster Paper

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### MOBILE GRAIN COOLERS

by

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#### 1. Introduction

Cooling bulk grain arrests deterioration, inhibits grain infesting insects and prevents rapid breakdown of insecticides applied to the grain. The cost of refrigeration arrests decision-making, inhibits imaginative thinking and prevents the breakdown of traditional attitudes to grain protection! Mobile grain refrigeration units enable those handling and storing grain to spread the cost of acquiring the equipment over a large number of stores of different shapes and sizes at many sites over a wide geographical area. A Cooler that can be towed at normal road speeds and which provides a compartment for carrying accessories required to connect it to any silo is ideal. The Poster presents an Australian made Mobile Grain Cooler which meets these criteria.

#### 2. Poster Layout

The left side of the Poster shows how high grain temperatures cause the characteristic caking of the surface grain, the sweating under the roof of a silo and the build-up of mouldy grain on the walls and floor of silos. These problems are not caused by high moisture content or by water leaking through wall joints or cracks in the floor as many suppose. The brochure describes how cooling removes the cause of moisture movement and other consequences of storing grain at the normally high initial temperature as harvested.

The central area of the Poster depicts applications of Mobile Grain Coolers and lists a number of other uses to which the Coolers could be put, some of which are not related at all to the preservation and storage of grain. Imaginative clients have proposed many other ways in which these very versatile mobile coolers can be used from drying honey in the tropics to cooling aircraft undergoing regular maintenance in hangars.

The right side of the Poster deals with operation and performance of McBea Mobile Grain Coolers. The simple operating instructions refer to the "Grain Wet-bulb Temperature" which has been found by Desmarchelier to be a very good indicator of grain quality control parameters. The performance graphs relate the operation of the refrigeration system directly to the wet-bulb temperature of the air between the seeds in a bulk of grain. This enables the data compiled by Desmarchelier (1988) on the multiplication rates of various grain infesting insects to be integrated with the various engineering heat transfer and air flow parameters. For a given Cooler, the effect on four species of grain insect of changing the size of the aeration ducting or the shape of the silo can be assessed. The effect of different atmospheric conditions or seed types can also be gauged. The simplicity of the controls and the

important easy-to-use features are highlighted with the photographs of the RMI806C Series available for hire.

The caption at the foot of the Poster emphasizes that cooling is a total quality control procedure and is accompanied by a summary of a selection of generic benefits.

### 3. Discussion

The mobility of these Grain Coolers permits operators to bring the quality control treatment to the stores where there are most likely to be problems. The utilisation factor is therefore likely to be far greater than for permanently installed plant. Control rooms and reticulated wiring or plumbing which can be expensive at remote sites are not required. A suitable electrical power connection is all that is necessary. The Coolers are weather-proof being based on standard commercial roof-top packaged air conditioning equipment manufactured by Email York, Australia. The refrigeration system is completely hermetic, the only servicing normally needed being the cleaning on the filter on the air inlet. If maintenance by a refrigeration mechanic is ever required, the Cooler can be towed to the workshop for attention. This will usually mean that the Cooler is returned to working order much more rapidly than if it depended on the availability of a serviceman to travel to a remote location. Cost savings would also accrue from this.

The refrigerant used is not subject to current restrictions under the Montreal Protocol. It is variously described as a non-CFC compound and its ozone depleting effect is only about one twentieth of that of the CFC normally used in automotive air-conditioners.

Cooling grain is a means of slowing down all biological and biochemical activity within the stored grain ecosystem. It is therefore ideal for long term storage preserving the grain in a natural environment. There are no restrictions to access to the grain at any time and is therefore highly suitable where grain is being used regularly for processing or where movements of small consignments of grain in and out of a large silo or shed is normal practice. Refrigeration brings grain temperatures down to a level where insects cannot multiply as shown on the Poster. This feature also reduces the risk of the development and spread of strains of insects which may be resistant to insecticides used as part of an integrated pest management strategy. Cooling can complement the fumigation of silos by decreasing the grain temperature at the end of the exposure period. This is particularly important where the insecticidal treatment depends for its effectiveness on encouraging insect activity so that the animals succumb quickly to the lethal effect. If the grain temperature required for this is allowed to remain high, any resistant strains in the insect population are likely to multiply quite rapidly and threaten the long term efficacy of the treatment.

High grain temperatures not only encourage insect infestation but also lead to other common storage problems as shown by the Poster. The grain temperature required to inhibit the emergence of progeny of infesting insects is governed by its moisture content and this condition corresponds to an intergranular air wet-bulb temperature. On the Poster, two of the performance graphs based on wet-bulb temperature can be interconnected to relate zero population growth to grain moisture and temperature for wheat. This in turn can be related to the Cooler's performance. A throttling device can be used to restrict the flow of air through the Cooler to vary its performance in accordance with the temperature criterion for any

particular insect or other quality control parameter. Only a few iterations based on the example given will be needed to establish the desirable operating condition of the Cooler in a given situation.

#### 4 Conclusions

The many advantages of cooling bulk stored grain are presented and lead to an understanding of this treatment as a total quality control system having beneficial effects on germination, seed quality and protectants as well as suppressing moisture problems, mould growth and insect activity. The discussion shows the importance of cooling in preventing the spread of strains of insects resistant to currently used insecticides. The simplicity and versatility of the Mobile Grain Coolers offer grain storage managers opportunities to introduce the technology with ease. The design, based on commercial air conditioning equipment and using a non-CFC refrigerant, is not likely to become obsolete. Construction from the standard refrigeration system components of a major air conditioner manufacturer ensures that there will always be spare parts available for the Coolers in the unlikely event of a fault occurring.

#### 5. Reference

Desmarchelier, J.M. - The relationship between wet-bulb temperature and the intrinsic rate of increase of eight species of stored product Coleoptera. J. stored Prod. Res. Vol.24, No.2, pp. 107-113, 1988

# LES REFROIDISSEURS DE GRAIN MOBILES

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## RESUME

Il est facile de démontrer que la dépréciation classique des stocks de grains en vrac est due à une température du grain trop élevée conduisant, par conséquent, à l'apparition d'humidité et de ses corollaires. Nous présentons les photographies des refroidisseurs de grain mobiles McBea en service, avec les détails du tableau de commande simple, des caractéristiques spéciales de l'équipement et du mode de fonctionnement général. Des graphiques de son fonctionnement mettent en évidence les paramètres relatifs au grain et au silo ainsi que les effets du système de réfrigération sur l'activité des insectes pour différents climats. Nous donnons un exemple d'utilisation des graphiques et suggérons d'autres applications du refroidisseur mobile. Une brochure décrivant l'équipement se trouve dans le porte-documents officiel donné aux participants de la conférence.