

APPLICATION ANALYSIS

DRY STORAGE



During the Civil War, more than twice as many soldiers died from disease as from enemy action. By the time of the Vietnam War, military forces had established effective preventative medical care, which eliminated such enormous waste of human resources.

But non-combatative losses remain a problem even in the 1990's. Military equipment resources, like the needlessly ill soldiers of the Civil War, are being destroyed more by corrosion than by enemy action. Fortunately, many units have found a way to avoid this expensive waste. They have adopted dry air protection, which, like medical care for soldiers, pays big benefits at minimal cost.

For example, a depot-level overhaul of a J-52 jet engine costs about \$500,000 and will be performed between three and five times over the life of the engine, depending on the amount of corrosion damage it sustains. Using dry air to reduce corrosion can save between \$500,000 and \$1,000,000 per engine for an investment of less than \$10,000 in dehumidification equipment. That's why so many military organizations have adopted dry air technology as equipment budgets get tighter and as personnel resources become more limited.

WHEN THE ENEMY IS CORROSION, THE WEAPON IS DRY AIR PROTECTION

Using dry air to prevent corrosion and deterioration is not a new idea—it's been proven since 1945 when the U.S. Reserve Fleet was laid up under dry air protection after WWII. In an era of reduced military budgets, this cost-reduction technique becomes much more important for three significant reasons:

1. Today's equipment costs much more than WWII gear.
2. Modern electronics are far more prone to humidity damage.
3. Protecting existing equipment is essential, since there is no budget for replacements.

Fortunately, dry air protection technology has expanded and evolved over the last 40 years to meet the changing needs of military organizations. In the 90's, controlling humidity has benefits that go well beyond simply preventing rust on Liberty ships. Dry air protection now provides:

■ Lower Cost of Operation

Studies throughout the DOD have consistently shown cost reductions when dry air protects equipment. In fact, audit reports have confirmed a 51% reduction in humidity-related maintenance for the AV-8B Harrier and a 29% reduction for the A-6E when dry air protected these aircraft on the ground between flights.

■ Reduced Hazardous Waste

Protecting equipment with dry air eliminates 95% of the need for hazardous liquids such as solvents, greases and oils. This saves the cost of acquiring the fluids as well as the cost of their disposal. Dry air systems allow organizations to meet new guidelines for hazardous waste reduction without sacrificing protection.

In one case, a Marine Aviation Logistics Squadron in North Carolina used dry air protection for contingency support equipment, eliminating the need for six-month preservation-depreservation-represervation cycles that would other-

wise be required. That saved over 2,000 gallons of hazardous liquid each year. Buying and then disposing of those liquids costs over \$29,000 every year, which can be saved for a one-time investment of less than \$10,000 in Cargocaire dehumidifiers.

■ Improved MTBF for Electronics

Without the danger of corrosion from condensation, electronic components are more reliable. The Dutch Air Force achieved a substantial improvement in reliability when they installed dry air protection on their Patriot Missile Defense Systems. And U.S. DOD audits have confirmed that dry air protection extended the Mean Time Between Failure (MTBF) by 33% for the avionics installed in Harrier jets.

■ Redirection of Manpower for Mission-Critical Tasks

As staffing levels and skills have become more limited, using scarce manpower resources to repair and maintain corroded equipment is no longer practical. Dry air protection allows the organization to redirect manpower to critical tasks without fear of losing equipment to corrosion and deterioration.

For instance, one Logistics Squadron saved labor as well as reduced hazardous waste with dry air protection for 148 pieces of equipment. The squadron was able



to redirect more than 14,707 man-hours over a five-year period, providing enhanced support for mission-critical tasks. When those tasks are performed by a contractor at \$16.00/hr, the value of dry air protection is over \$235,000.

■ Commercial Off-the-Shelf Solutions (COTS)

Because dry air protection has been so widely used in both military and commercial applications, desiccant wheel (DEW) dehumidifiers are non-developmental items (NDI). There is no lengthy development time needed for dry air protection, and no need to make costly modifications to existing commercial hardware—all of that was accomplished years ago.

WAREHOUSES PROVED THE BENEFITS OF DRY AIR

During the 1950's, dry storage was applied widely by all branches of the U.S. Military. The Army even published Technical Bulletin 256 "Controlled Humidity Storage", which provides extensive guidance for warehouse construction and the installation of desiccant dehumidifiers for humidity control.

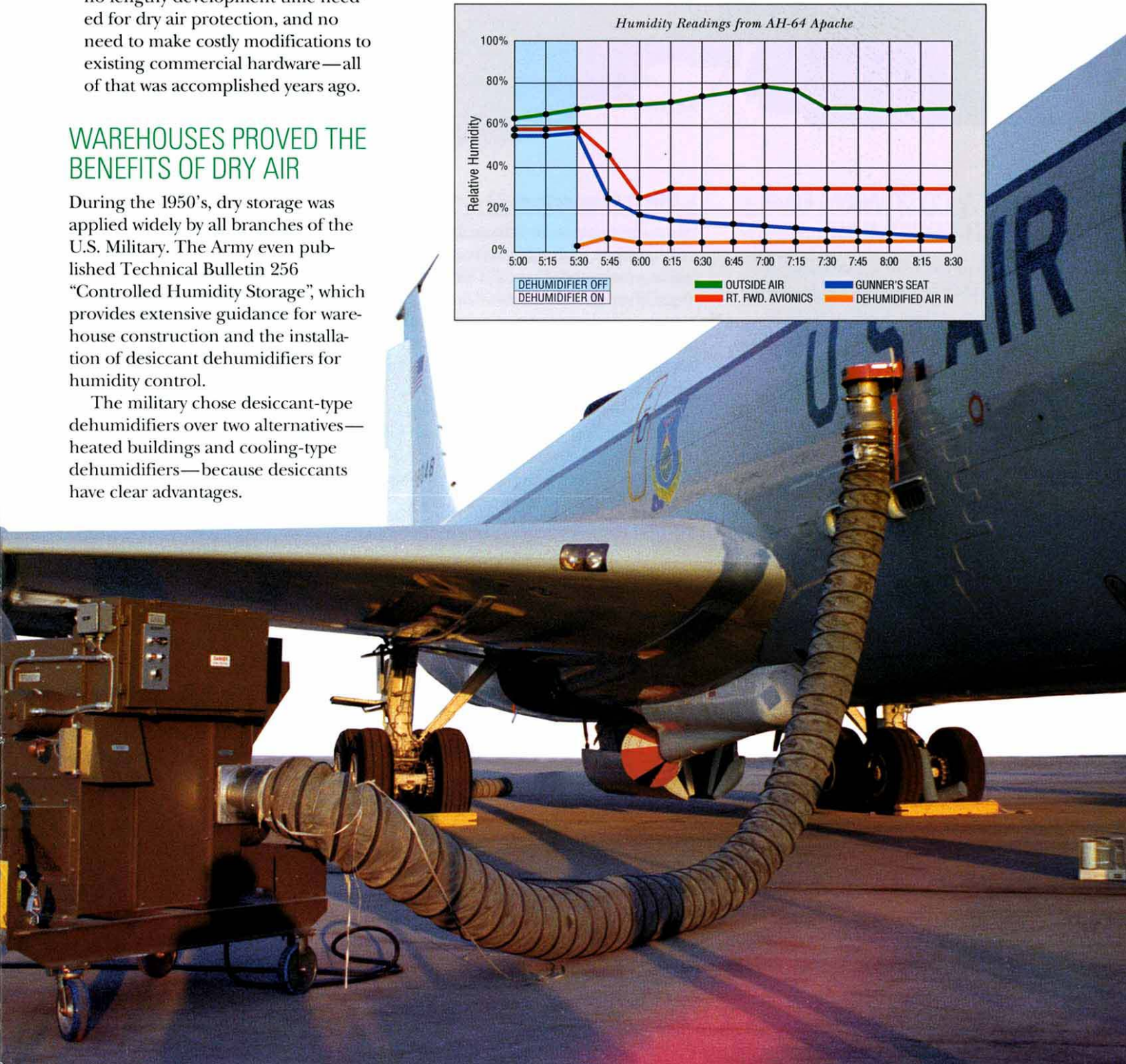
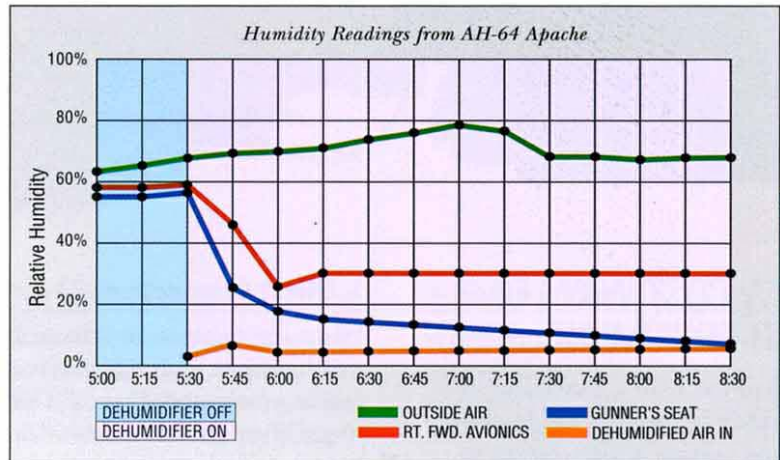
The military chose desiccant-type dehumidifiers over two alternatives—heated buildings and cooling-type dehumidifiers—because desiccants have clear advantages.

Heating to control humidity is both costly and ineffective. Military equipment is heavy and has great thermal inertia. Heating the air does not warm the equipment fast enough to avoid condensation when humidity rises quickly, such as during springtime or during a summer rainstorm.

Cooling-based dehumidifiers are limited in the amount of moisture they can remove at cool temperatures. These units freeze up in fall and winter when temperatures drop below 65°F. Additionally, military organiza-

tions found that even in warm climates, cooling-type dehumidifiers do not have the capacity to control humidity between 30 and 40% RH, which is the level needed to meet specifications for corrosion control.

Consequently, the durable, all-weather capabilities of desiccant dehumidifiers became the technology of choice for military humidity control. Now, the basic idea of dry air storage has expanded greatly as Cargocaire units have been tailored to meet changing military requirements.

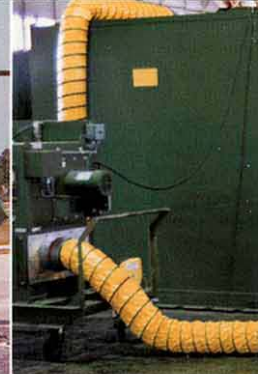




1.



2.



6.



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TEN LOW-COST WAYS TO PROTECT EQUIPMENT

Beginning in the 1970's, European military organizations, notably the Swedish, German and Danish armies, began to use Munters desiccant wheel dehumidifiers in applications beyond long-term storage. They used desiccant wheel units to protect active-duty equipment in the field, which required development of portable, weather-tight desiccant units. The Israeli Defense Forces developed small shelters for use in forward areas as well as two-part protective bags for vehicles which allow for fast drive-away capability in times of crisis. U.S. Military organizations have followed with additional variations in an active dry air preservation program begun in the 1980's. Here are ten examples.

1. Direct Connection

When the equipment is basically weather-tight, portable desiccant units can be connected directly. This technique is especially useful for active-duty equipment where fast response and simple preparation is essential and more important than protection of the equipment exterior.

2. Direct Connection with Partial Cover

When equipment is not completely weather-tight, the item can be equipped with a loose-fitting partial cover. Then a Cargocaire dehumidifier protects the interior without the difficulty of drying out rainwater. A loose cover keeps the size of the desiccant unit small, and the cover can be removed quickly, maintaining the fast reaction times required for active equipment.

6. Interior Dry Air Zone

In many older military bases, large buildings are available for rain protection, but these may have too many air leaks to control humidity. Often these buildings are so large that they would be prohibitively expensive to seal against air infiltration. In that situation, many organizations have constructed dry air zones inside the building. A simple lumber-frame room is built with its own ceiling. Then chicken wire or hardware cloth is stapled to the frame and plastic sheeting is taped over the wire support. The surrounding building provides protection from rain and snow, and the interior dry air zone protects equipment from high humidity without the need to seal the entire exterior envelope.

7. Micro-Shelter

When many smaller pieces of equipment need protection, or when the equipment needs some structure for protecting antennae or other projections, a micro-shelter may be the best choice. These small shelters combine the light weight and rapid deployment of a cover, with the protection of light weight structural supports. Micro-shelters can be placed partly below ground level for better camouflage without impacting response times.



3. Shipping Containers

Low-cost, high-strength shipping containers are an excellent choice for dry air storage. Such containers are also completely portable. In the photograph above, war readiness material (WRM) is stored in air freight containers and protected by Cargocaire dehumidifiers connected to each container through simple, low-cost PVC pipe. The familiar and widely available sea lift containers also have a large internal capacity for supplies and equipment. These are often connected to dehumidifiers to protect the material from mildew and corrosion, as well as from wind and rain.

4. Two-Part Covers

In many cases, fitted covers are the best solution, but reaction time would be adversely affected by the time needed to extract the item from a tight-fitting cover. In this situation, the cover can be made in two pieces. The bottom piece is laid on the ground, then plywood is put in place as a floor and the equipment is positioned on top of the plywood. Finally, the upper cover is placed over the equipment and joined to the bottom piece with either zippers, hook-and-loop fasteners, snaps or lanyard cord.

5. Shrink-Wrap

When equipment will be stored for extended periods, or when it must be protected for open-deck ocean shipment, shrink-wrap provides a low-cost, single-use tight cover to contain the dry air produced by a Cargocaire dehumidifier. Shrink-wrap is best applied when the equipment is completely dry before wrapping, so that water is not trapped between the plastic wrap and the equipment exterior.

8. Tightened Room

When an organization does not have access to large warehouse space, existing rooms in smaller buildings can be used for dry air storage. With the drying capacity of Cargocaire desiccant units, the only additional requirement for dry air storage is protection from air leaks. The room shown above was tightened easily by sealing the normal construction joints with aluminum foil duct tape. Later, a lumber-frame mezzanine was built inside the room to add storage capacity without taking up more floor space.

9. Fabric-on-Frame

Even if military construction budgets do not allow for permanent warehouses, an organization can gain large amounts of high-quality storage space by purchasing fabric-on-frame shelters for humidity-controlled storage. These can often be acquired with operational funds and erected with self-help labor, providing excellent protection in a fraction of the time needed to plan and approve a military construction budget.

10. Electronics Vans

Like shipping containers, electronics vans are ruggedly built to protect their contents from wind, snow and rain. Consequently, they also make excellent dry air protection enclosures. Connecting Cargocaire dehumidifiers to such vans prevents the condensation that often occurs when electrical equipment cools off as it is powered down. Without condensation, the all-too-familiar start-up problems are greatly reduced and excessive recalibration is avoided, improving readiness while controlling maintenance costs.

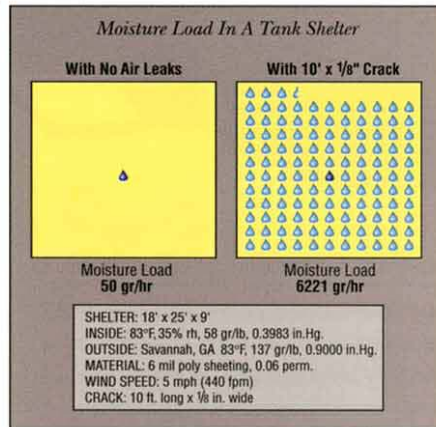
EASY TO APPLY

Installing dry air protection equipment is simple and inexpensive. Cargocaire Division's military application engineers are ready to help answer questions you may have concerning the techniques and will offer advice from the experiences of other organizations which have used DEW equipment in the past.

Based on our observations of those experiences, we find that the following issues are useful to understand as you plan a dry air protection project.

Vapor Permeation vs. Air Infiltration

While it is important to minimize the permeation of water vapor through walls, bags and floors, it is far more important to limit humid air infiltration. The graph below shows why. When stormy weather blows humid air through cracks, the moisture removal rate required to maintain 40% RH increases greatly. It is much more productive to spend time taping joints rather than searching for better, low-perm vapor barriers. Any enclosure will work well, as long as its joints are taped shut.



Although minimizing vapor permeation is useful, it is far more important to eliminate cracks which allow humid air to enter the protective enclosure. Cargocaire dehumidifiers can remove any moisture that enters the enclosure, but if air infiltration is reduced, a smaller dehumidifier can be used.

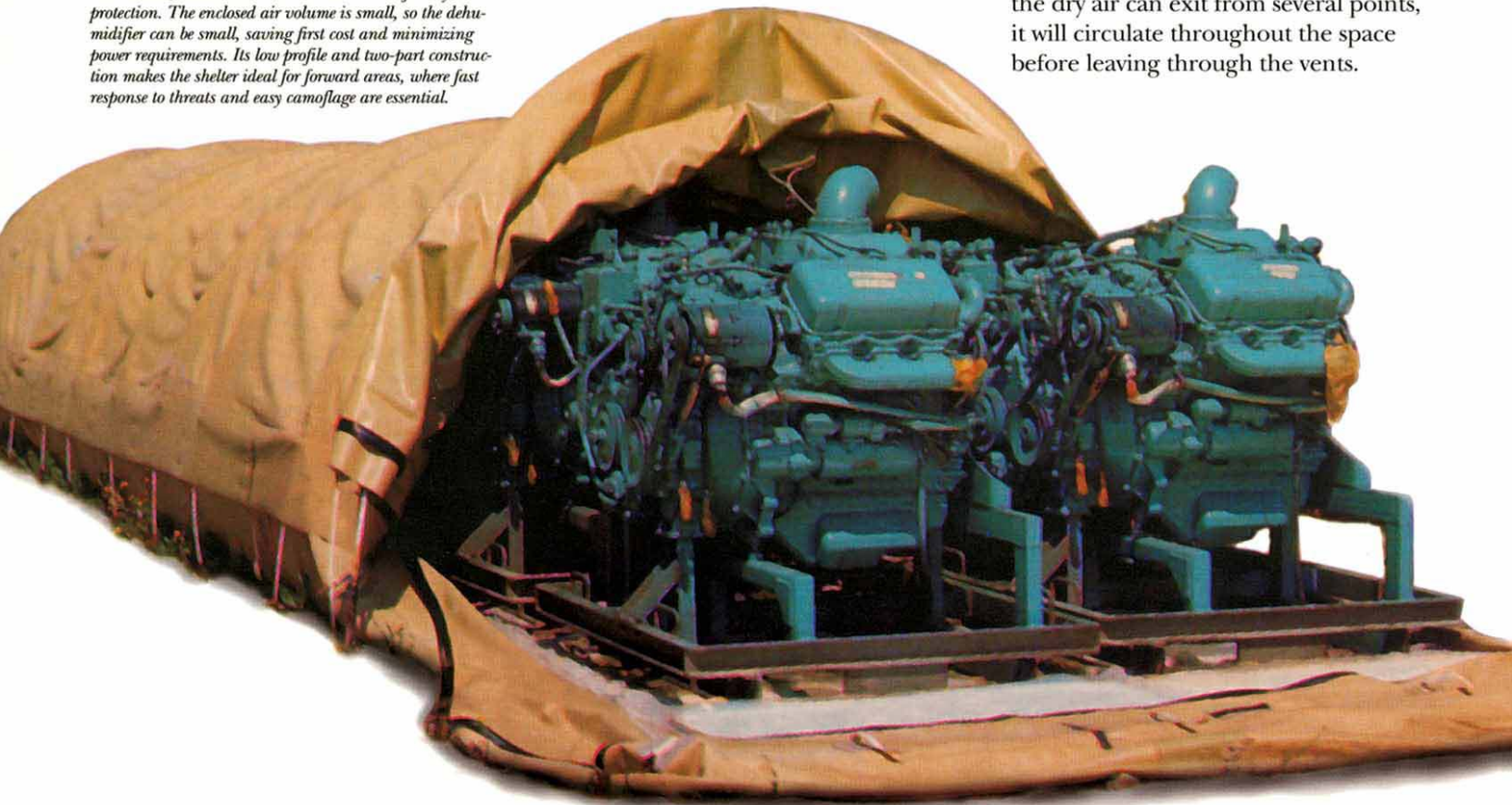
Multiple Units for Large Enclosures

When a dry air enclosure is very large, the project manager may wish to locate small dehumidifiers in different parts of the building instead of using a single large central unit. Dividing the overall load among several dehumidifiers provides useful redundancy in case of equipment failure, and also simplifies air supply and return duct work, since each unit serves a local zone. With multiple small units, individual zones can be controlled more closely as their local loads change. And the overall installation will use less energy since each small unit operates only when its local humidity is high, rather than forcing a large central dehumidifier to dry the entire enclosure to reduce high humidity in a single zone.

Avoid Dead Spots

For best protection, the air should circulate throughout the enclosed space. That way, any infiltration of outside air cannot build up to create pockets of high humidity. If the dry air system recirculates air back to the DEW unit, the supply and return points should be located on opposite sides of the enclosed space, so air will circulate throughout the whole area. If the dry air system purges the enclosure, several openings—each equipped with back-draft flaps—should be located in different parts of the enclosure. Since the dry air can exit from several points, it will circulate throughout the space before leaving through the vents.

This mobile, relocatable micro-shelter is ideal for dry air protection. The enclosed air volume is small, so the dehumidifier can be small, saving first cost and minimizing power requirements. Its low profile and two-part construction makes the shelter ideal for forward areas, where fast response to threats and easy camouflage are essential.



Locate Controls Logically

Air leaving the dehumidifier will be warm and very dry. If that air blows directly on the humidistat which controls the dehumidifier, the unit may switch off before the entire enclosure is dry. The humidistat should be located near the part of the equipment which is most important to protect. For example, aircraft avionics are expensive, and corrosion can generate a need to recalibrate. So in an aircraft, a humidistat should be located near the avionics, since that is the most important item to protect.

When equipment is very large, such as the C-130 transport aircraft, there may be a need for more than one humidistat, since the humidity can vary within large, complex equipment with many enclosed spaces. In such cases, the humidistats are wired in parallel so the dehumidifier will switch on if any of the humidistats call for reducing the humidity.

In some cases, there may be a large temperature difference between different points in a dry storage enclosure. Large metal sheds in the northern hemisphere may be cold on northern sides even when the sun warms the southern exposure. In this situation, it may be useful to connect a dew point controller in parallel with the humidistat. The dehumidifier can then switch on when there is any danger of condensation on cold surfaces—a condition that will not be apparent to the humidistat when its sensor surface is warm. The dew point controller should be located at the coldest point within the enclosure.

No Need to Control Vacant Space

If the building is large and the equipment small, such as armored personnel carriers parked in an aircraft hanger, there is no benefit to keeping the space over the personnel carriers dry. The vehicles can be covered with plastic, and the dehumidifier connected to the area under the cover. This means the dehumidifier can be smaller and even more cost-effective than a dehumidifier large enough to keep the entire space dry.



WORLDWIDE SUPPORT

A useful advantage of working with the Cargocaire Division is the worldwide support available for your dehumidifiers. The Munters companies have local sales and service offices in over 25 countries. Cargocaire dehumidifiers are currently protecting tanks in the Middle Eastern deserts, keeping pre-positioned equipment dry on ships in the Indian Ocean and protecting aircraft from corrosion in Thailand and Australia. You can depend on us to support your equipment no matter where your operations require dehumidification.

CONSISTENT QUALITY AND LONG-TERM COMMITMENT

Cargocaire has been making desiccant dehumidifiers for over 50 years. Worldwide, Cargocaire and our Munters affiliates produce more desiccant dehumidifiers than all other man-

ufacturers combined. And our plants are ISO-9001 certified, so you can be assured of consistent, ever-improving quality and reliability.

Half a century of military-specific experience provides other benefits beyond application assistance and consistent quality. We support our equipment for decades. You can rely on us for service and parts no matter how many years your units remain in the field.

YOUR NEXT STEP: APPLICATION ASSISTANCE

The application engineers at Cargocaire Division are ready to help you assess the benefits of a dry air protection project, and help you with any questions you may have about the equipment, its operation or its installation. You can reach us at 800-843-5360.



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