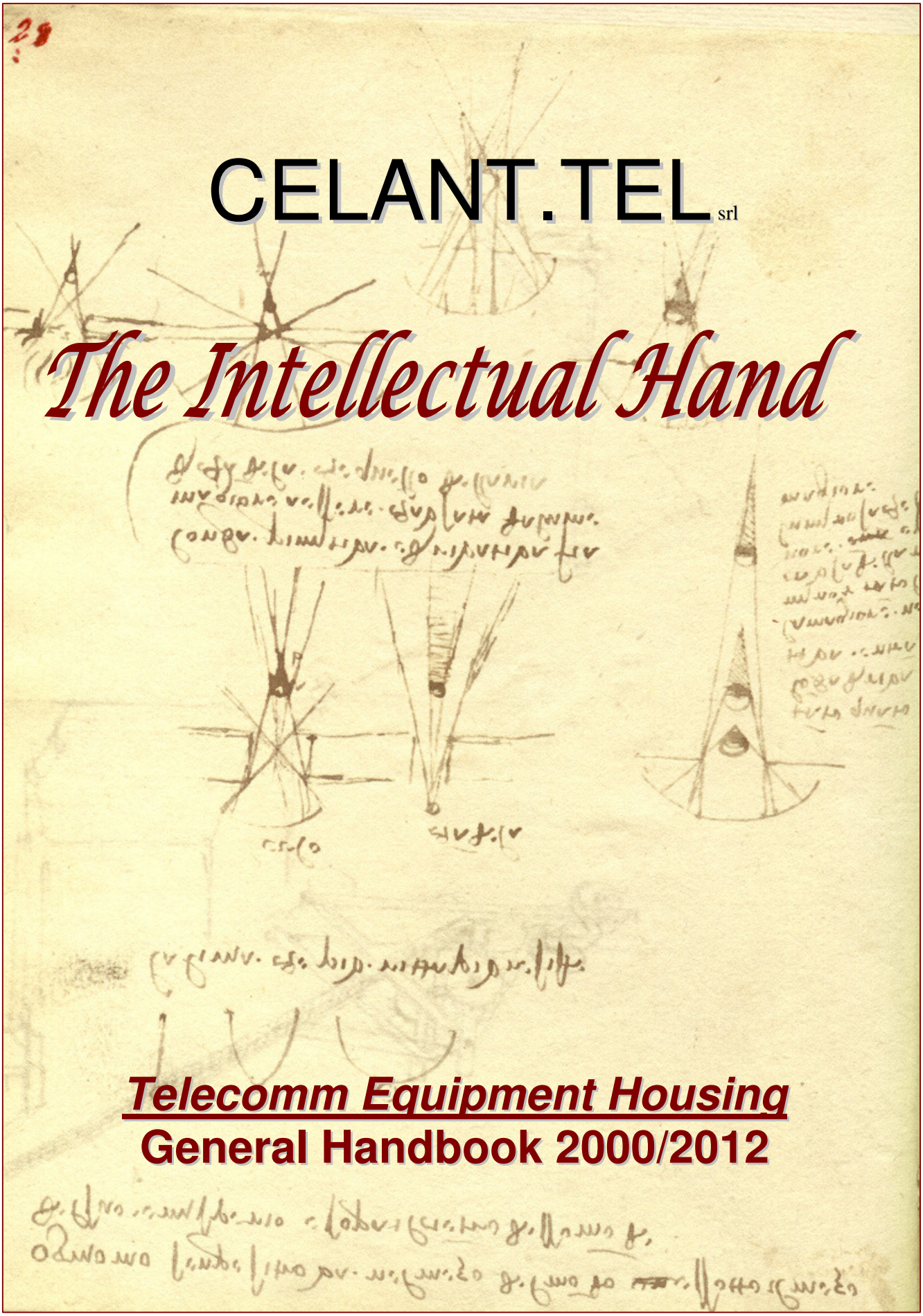
CELANT.TEL srl

The Intellectual Hand



Telecomm Equipment Housing

General Handbook 2000/2012

FOREWORD

Thirty years have passed since I started my extraordinary journey into the telecommunications field.

This professional itinerary has been rich in opportunities through travelling, meeting people, debating opinions, taking risk and a lot of work: Such a mixed experience it was that its memories needed to be switched into the written word.

The solutions put forward in the following pages draw from this experience. My aim is not to produce a technical essay, nor a generic outline of such a complex topic. I intend to offer a managing module and a research method for specialist approaching engineering of equipment shelters from different disciplines.

I would like to express my gratitude to all the people that have assisted me for so many years, and in particular Marco Merletti, who has acted as an essential interlocutor.

This work is dedicated to all of them, and I am sure that they will recognize in it outlines of their valuable contributions.

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I N D E X

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1. INTRODUCTION

CELANT.TEL was established with the aim of operating principally in the telecommunication market of infrastructure and services, offering the most suitable solutions to every problem of housing electric/electronic equipment and apparatus.

The performance of a telecommunication service essentially depends on the reliability of the complete system: apparatus + housing.

The concept of "housing" for CELANT.TEL means a sheltering structure optimised for the protection of electronic equipment and/or personnel against ambient stress, vandalism and manhandling.

This means that the internal conditions must be adapted to the outer conditions to obtain an ambient suitable for the effective protection of the equipment and personnel (if and when present).

One of the ambient stresses the equipment may be subject to is represented by thermal stress. The request for protection against this factor (conditioning) is the most important.

Air conditioning is without doubt the most difficult form of protection, being costly in design and management/maintenance.

On the other hand the major cause of telecommunication equipment failure (over 65%) is due to overheating of components used, even when properly installed and maintained.

Each solution, to be properly designed, cannot ignore the evaluation of: initial costs of the system; an analysis of operational costs; available energy, (quantity and type, cost, reliability); the dissipated energy (if continuous or intermittent); the accessibility of the station; etc.

CELANT.TEL considers energy saving a primary objective, therefore on each project requiring shelters an initial assessment is made on the use of passive or semi-passive devices.

The passive solution permits maximum reliability (MTBF) and functionality (MTTR) removing most direct and indirect costs due to operation, maintenance, replacements etc.

The above advantages are such that Passive Cooling Housing are considered mandatory solution whenever remote sites or those powered through alternative energy system are involved.

The challenge for CELANT.TEL is to extend these advantages to other applications different from the current traditional ones.

The possible applications would therefore interest: medium-high power stations, stations having traditional power supply (mains), radio base stations (BTS), microwave station, switching station, telecomm. building, broadcasting repeaters, NAVAIDS project, railways project , etc. located in any climatic conditions..

CELANT.TEL is capable of proposing and engineering a range of technologically advanced shelter constructions and energy saving air conditioning solutions suitable for the most varied applications.
These climatization solutions can vary from Water Base Technology (W.B.T.) which can be supported or integrated by Phase Change Material (P.C.M.) or/and Air/Air heat exchanger device, Hybrid Systems (Passive integrated with Active), conductive walls and other types of passive systems and devices achieving full energy saving (zero need of electrical power) or involving very little use of power.

2. GENERAL STANDARDS FOR TELECOMMUNICATION SHELTERS

The CELANT.Tel products are designed and manufactured in accordance with Specifications and Standards approved and adopted by the most important European carriers and providers and particularly those related to the temperature ie ETSI 300.
However, specific climatization solutions can be studied and accomplished meeting different internal temperature requirements.

Expected Life

The shelter's structural parts must have a life span of at least 20 years.

Expected Performance

Materials, devices, systems and auxiliary apparatus used must have characteristics of reliability according with the electronic equipment housed. In case of passive systems, they must guarantee their performance over the entire life cycle of the station ie 20 years.

Environment Compatibility

Use of materials and/or apparatus that may affect the ambient is not allowed.

Maintenance

The solutions proposed must have the characteristics of simplicity, durability, with zero or minimum of maintenance.

Resistance to Fire

Materials used must be at least self extinguishing of Class 1 resistance to fire according to CEI Standards.

Transportation

Suitable for transportation by standard haulage.
Monolithic shelters shall have the following characteristics:

- Dimensions according to ISO 104 (wherever possible)
- No protruding parts
- Packing not necessary
- No permanent deformation due to dynamic stress

In any case hoisting can be performed by connecting to the four base corners.

Installation

The shelters are required to lay on 4 base-plates only up to 15" length.

Electro-chemical couples

Compatibility of the various materials used must be observed to avoid corrosion.

Thermal uniformity

In the case of insulated shelters, construction of the body of the shelter, the door and openings must be such as to avoid or minimise any thermal bridge. Insulating material shall be fully moisture resistant and not subject to aging for the whole station life

Sealing

Sealing to standard IP55 or IP 65 must be ensured for all the above ground and underground tightened shelters respectively.
Thermoventilated shelter construction has to be such to prevent water and dust entering.

Equipotentiality

The entire surface of the metallic shelters must guarantee equipotentiality even if supplied in an unassembled kit form.

Structural materials

Stainless materials must be used in the construction, or at least, materials that have been surface treated to resist atmospheric corrosive agents, acid & alkali, pollution, etc.

Structural characteristics.

The structure of the body of the shelter must be designed to withstand the following loads as a minimum requirements:

	floor 500 kg/sqm distributed load (typically for equipment rooms) admitted deflection: does not exceed 1/400 of the diagonal (data relate to 15' shelter placed on 4 support at the corners).
	2500 kg/sqm concentrated load (typically for battery rooms)
roof	150 kg/sqm and anyway without deforming when heavily walked over
walls	wind of 160 km/h
seismic stress:	according to local standards

Installation of equipment

In all cases the following minimum availability shall be ensured:

- Wall fixing: everywhere is required through C-rail or fixing device
- Floor fastening: everywhere through suitable fixing bolts

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Surface finishing

If shelter body is made of lightweight alloy, stainless, fibreglass the surface treatment has mainly an aesthetic function. Standard finishing will be applied, colours at customer's choice (restrictions in the colour selection in case of severe environmental conditions and/or passive conditioning).

For steel (not stainless) shelters a hot dipped galvanisation cycle is foreseen for the shelter elements according to standard CEI 7/6 (or equivalent ASTM)

Where heat exchangers has to be located outside in presence of harsh environment i.e. H_2S, copper components will be adequately protected.

Dent & scratching surfaces resistance

To avoid or reduce risk of damages during handling, transport and operative life of the shelter, it is very important that all external surfaces provide high scratching and dent resistance.

Non hazardous

The finished product will be will have no sharp edges and have smooth edges.

Thermal requirements

When not specified by the customer the standards ETSI 300-019 are used.

Shielding standards

When required Electro-magnetic compatibility according to:

EMC EN-50081-1

Use and maintenance

Shelter body and associated system & fittings are designed to simplify their use and minimise their maintenance.

Galvanic insulation

Direct contact of different metals is not permitted. If impossible, provision will be taken to avoid galvanic effects.

3. CONSTRUCTION TECHNOLOGIES OF SHELTER BODIES

METALLIC CONSTRUCTION

Material: Mild steel

Stainless steel

Lightweight aluminium alloy

Construction Technologies:

A. Jointing of components (framing and walls) by continuous welding;

Internal insulation and covering:

- Direct P.U. foaming process onto internal surface of walls, floor and ceiling and interposition of covering panelling (obsolete tech.)
- Inter-positioning of prefabricated sandwich type panels with configuration on request.

Advantages:
- robust and compact
- perfect sealing
- body & door can be of any dimension

Disadvantages:
- high cost of manpower required for construction
- aesthetically poor as similar to an ISO container
- thermal bridges

B. Carrying structure: in lightweight aluminium extruded profiles or folded pressed and welded steel construction.

Pluming: prefabricated modular sandwich type panels with cladding configurations on request.

Notes

(*) It is the most common and cheapest technology adopted in shelter construction.

(**) Framework requires the joining between structure and multiple panels and among panels as well, thus creating problems such as: materials compatibility, sealing, mechanical joining, different thermal expansions, external protection, thermal bridges.

(***) Multiple intermediate junctions among the panels and between panels and framing are ensured by silicone sealant. The above junctions are subject to mechanical and thermal stresses, which can create, in the long-term, crashes and relevant water penetration.

FIBER REINFORCED RESIN (FRP) CONSTRUCTION

This type of construction enables the manufacture of any type of shelter body of a monolithic type or a prefabricated and knockdown type without dimensional limits.

The panels used are of the sandwich monolithic type, fibreglass/Polyethylene or P.U./fibreglass, with internal fibreglass ribbing and reinforcement manufactured under a controlled thermal/pressing process. The internal/external surfaces may have a metallic layer (aluminium or stainless steel - on request).

CHARACTERISTICS

- A solid "egg" made through Composite Panel Construction Technology that avoids metallic frame. It has a very pleasing visual aspect as the surface is perfectly plain, smooth and without any joint lining or joining devices such as screws, bolts and rivets etc.
- It is entirely without thermal bridges and has a high insulation uniformity.
- It allows the highest grade of insulation with an equal wall thickness and a larger inside area with an equal insulation.
- Perfectly square with no protuberances from the openings. Unlimited lifetime with a no maintenance.
- Extremely high scratching & dent resistance of all surfaces.
- Totally acid-alkali and corrosion proof
- Easy to repair.
- Unlimited lifetime (no reduction of characteristics, etc..).
- Light in weight.

This type of construction is the most suitable one for any energy saving shelter solution and in particular for passive shelter

KNOCK-DOWN TYPE SHELTER

This configuration allow great transportation cost & risk savings. It is highly recommended for project involving considerable number of shelter.

4. HOUSING TYPOLOGIES

Before listing the types of telecommunication housings available it is recommended to point out operating conditions as follows:

- **ambient stress in the specific climatic area**
- **heat dissipation of housed equipment**
- **operating temperature of housed equipment (max. and min. permitted)**
- **type of energy available**
- **size of the station**

Identification of climatic areas:

- **Temperate:** on an average between 25° lat. - 50° North, South
- **Desert:** on an average between 10° lat. - 25° North, South
- **Equatorial** on an average between 0° lat. - 15° North, South
- **Arctic**

Indicative dissipation of each type of apparatus to be housed:

RADIO LINKS

• Small capacity	10 to 80 W	mini containers or cabinets
• Rural satellite	up to 800 W	cabinet and shelters
• High capacity shelters	up to 2.0 kW	above and below ground

MOBILE NETWORKS

• Optical cabinets :	up to 1.5 kW	cabinet
• BTS Stations :	up to 3.0 kW	cabinet; shelter; building
• Switching :	up to 1.5 kW	cabinet
	up to 5.0 kW	shelter
	over 5.0 kW	building
• Earth station :	up to 10.0 kW	shelter
	over 10.0 kW	building

BROADCASTING

- Micro-repeaters : up to 200 W cabinet
- Repeaters : over 200 W shelter, building

FIBRE OPTIC

- Nodes : up to 200 W below ground shelter
- Stations : over 200 W above and below ground shelters, building

Etc.

Working Temperature

Equipment: to be agreed with customer or application of existing standards (ETSI, etc.).

Personnel: to be agreed with welfare standard or specific client request.

Type of Power

Nearly all the applications mentioned may be powered from the mains power supply or by battery. The batteries of the stations may be powered in turn from: mains supply, photovoltaic cells, thermo-turbo-diesel generators, aeolian, hybrid systems etc.

Size & layout of the Station

Depending on customer and project needs.

5. AVAILABLE SOLUTIONS

Passive Housing

DEFINITION

A housing is considered to be "passive" when the energy necessary for its conditioning is supplied entirely by the thermal energy available from the natural alternation between day night and the seasons.

Note : The housing is considered also passive when a very small energy consumption is required, it shall not be continuous and finalised to the improvement of the system efficiency (not to guarantee the system operation). The maximum power allowed is 5% of the equipment consumption.

TYPES AND USE

Passive systems with storage

These are used when the maximum internal temperature is less or equal to maximum external temperature. It is a typical solution for desert areas but can also be applied also to temperate zones.

Passive systems without storage

These are used when the maximum internal temperature is higher than the maximum external temperature. These are typically used for equatorial zones.

Note It must not be taken for granted that a passive system chosen for a temperate or desert area is the best solution for an equatorial area.

Semi-Passive Housing

DEFINITION

A housing is considered to be "semi-passive' when the energy necessary for its conditioning is **not supplied entirely** by the thermal energy available from the natural alternation between day and night and the seasons.

Note : In any case the maximum power allowed is 20% of the equipment consumption. The lack of energy must not affect the equipment operation and its life.

TYPES AND USE

Semi-passive system with storage

These are used when the maximum internal temperature is less than the maximum external temperature. It is a typical solution for desert and temperate areas; it enables a more efficient conditioning even with higher power dissipation than that managed by the passive system. It is also more adaptable for conditioning of apparatus rooms in buildings.

Semi-passive systems without storage

These are used when the maximum internal temperature is higher than the maximum external temperature.

Passive Self Ventilated Housing

In this case the shelter is not hermetic or sealed from the external ambient. Thermal control is made by natural convection between the cooler external air and the internal warmer air.

The device that enables communication between the internal and the external ambient is of the passive type.

These shelters can be used in temperate and equatorial zones when the internal temp. is higher that the external temperature.

Active Conditioned Housing

DEFINITION

A housing is considered to be "active" when the energy necessary for its conditioning is **supplied entirely** by available electrical power.

This can be used in all climatic areas.

Hybrid Conditioned Housing (Passive plus Active)

Typical application is for high capacity solar powered GSM stations since it can conveniently utilize the exceeding electrical power available during the hottest hours. The active system intervenes as a back up of the passive one lowering the peaks of excess temperature due to thermal stress and/or exceptional power consumption.

This can be used in desertic and hot temperate areas

6. EXAMPLES OF DISSIPATION LIMITS AND CHARACTERISTICS

PASSIVE SYSTEMS WITH STORAGE

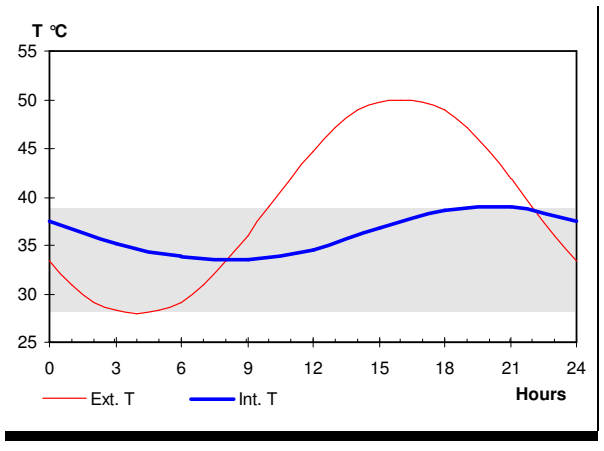
The re-occurring applications for conditioning above ground shelters use H_20 and/or Phase Change Material (P.C.M.) as thermal capacitance.

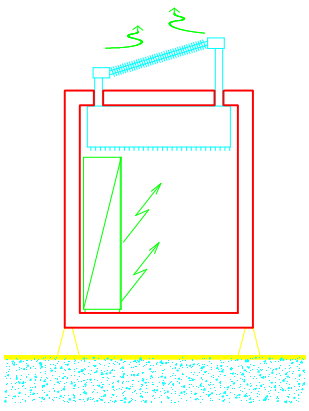
P.C.M. can be employed when the available ΔT between minimum night temperature and maximum internal temperature is at least 15°C.
The shelter is hermetic and characterised by insulated walls with an absence of thermal bridges.
The grade of insulation depends on the dissipation from the housed equipment, on the difference between the minimum night temperature and the maximum internal temperature and on the amount of night cycle time in respect to the day cycle.

Energy that can be dissipated ~400 W*

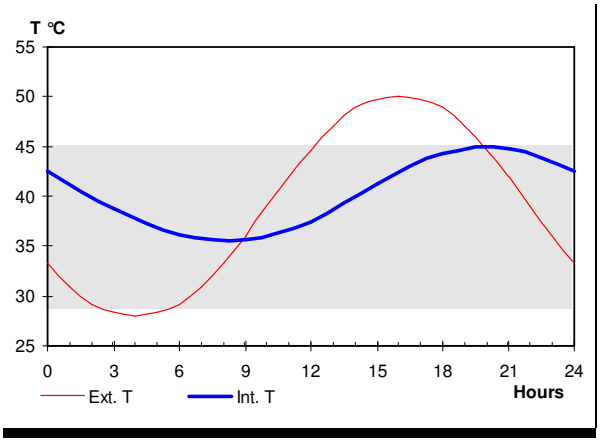
*The power refers to a standard module 2.5 in length and 1 mt. width operating under standard requirements.

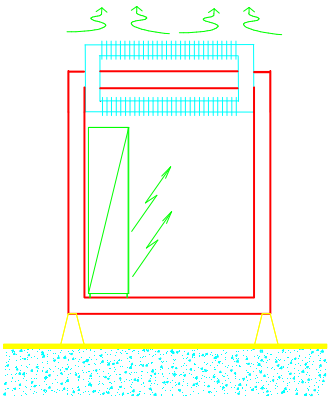
N.B. Limits of the amount of power dissipated essentially depends on the difference between max. night external temperature and max. allowed internal ones.



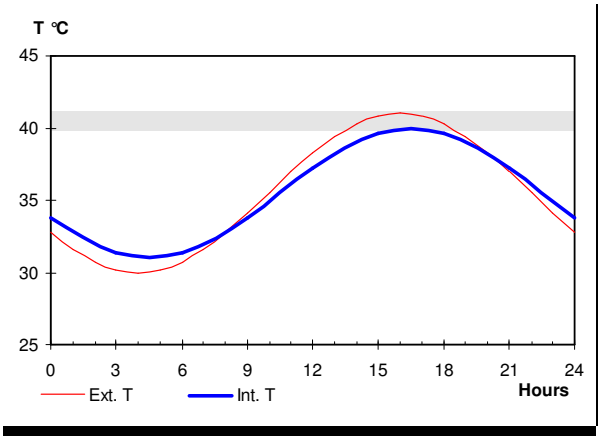


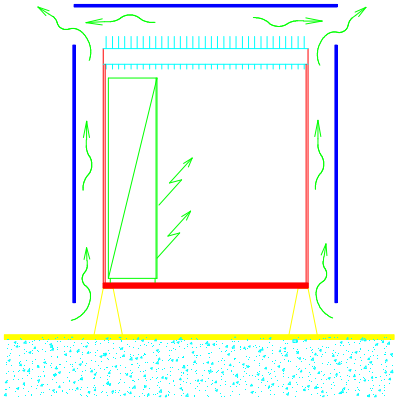
TYPICAL WATER BASED SYSTEM



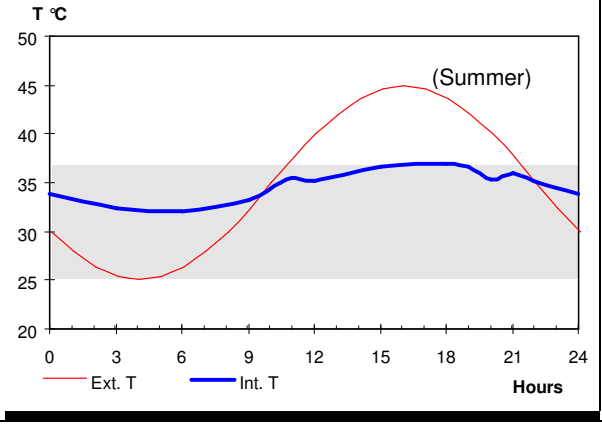


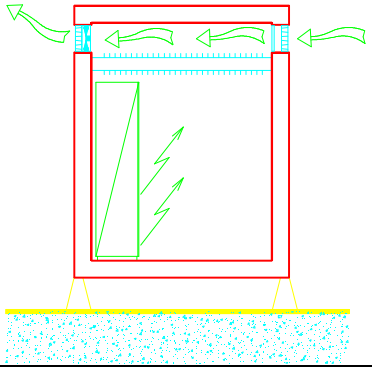
TYPICAL PHASE CHANGE MATERIAL SYSTEM





TYPICAL CONDUCTIVE SYSTEM & STORING CAPACITY

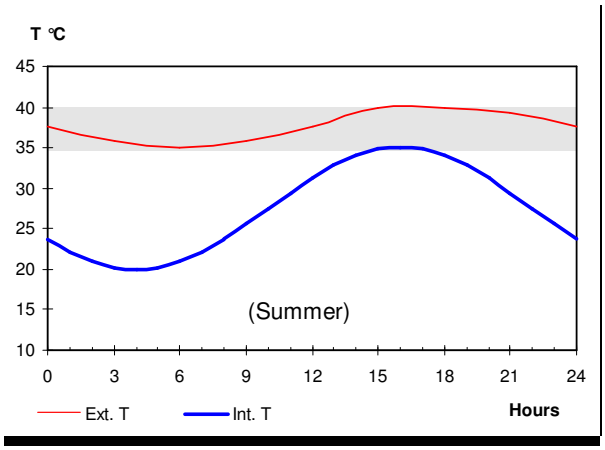


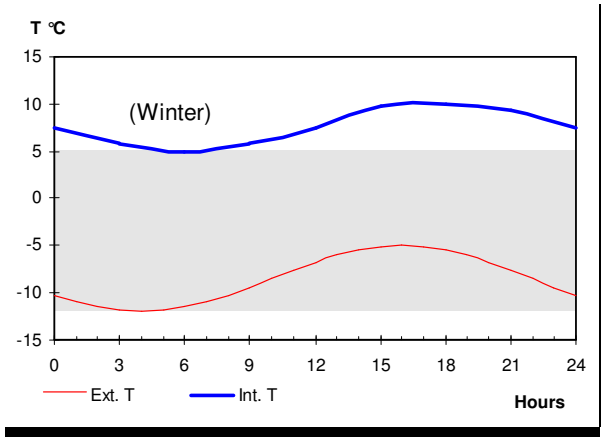


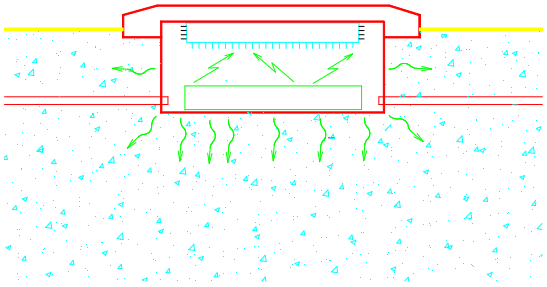
TYPICAL P.C.M. + H_2O SYSTEM

OTHER EMPLOYED APPLICATIONS OF THE STORAGE SYSTEM

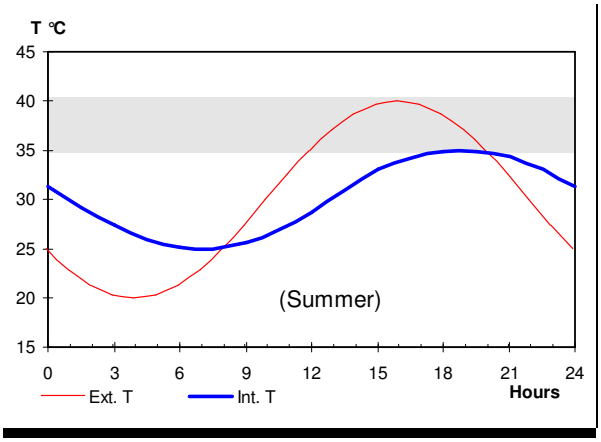
Underground housings

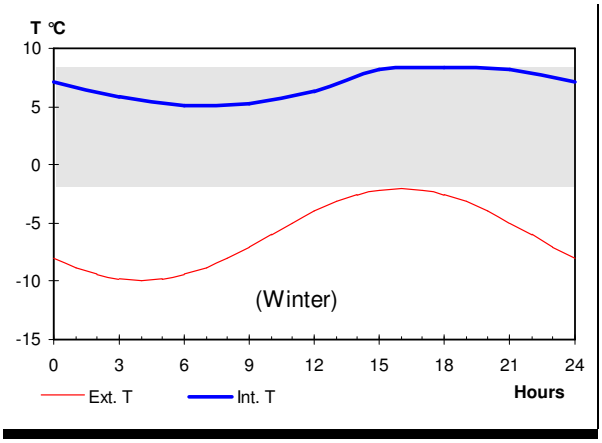


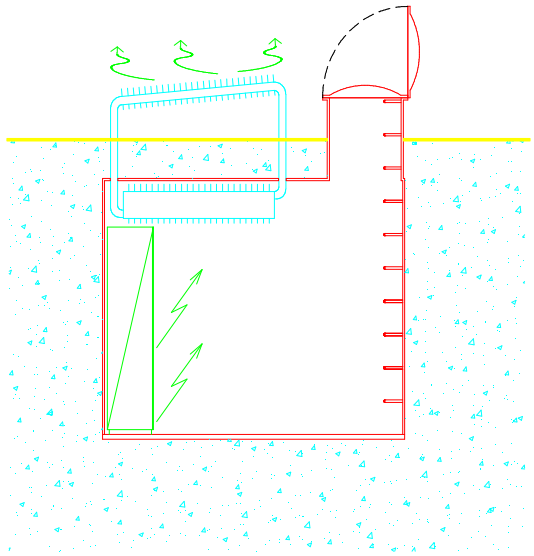




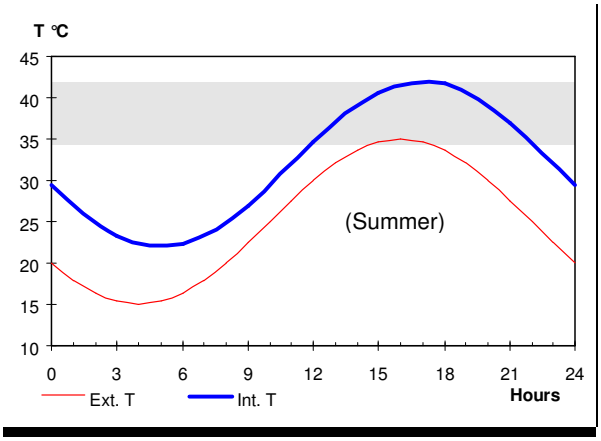
TYPICAL BURIED CABINET

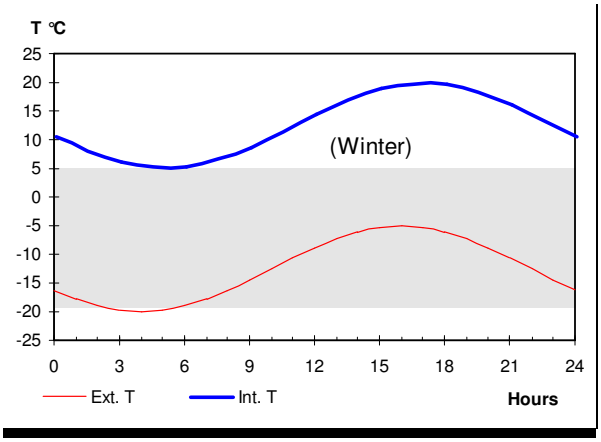


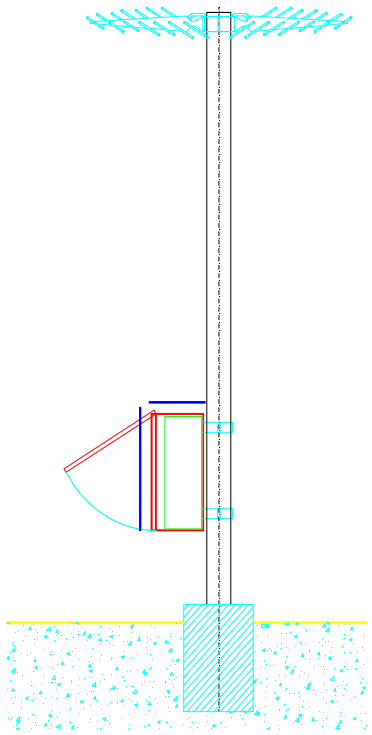




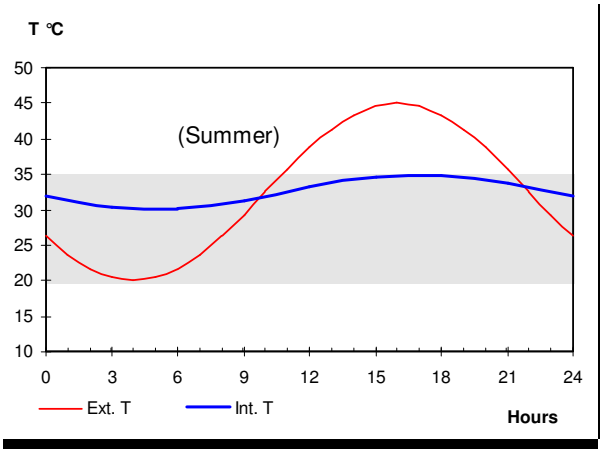
TYPICAL BURIED SHELTER WITH MANHOLE

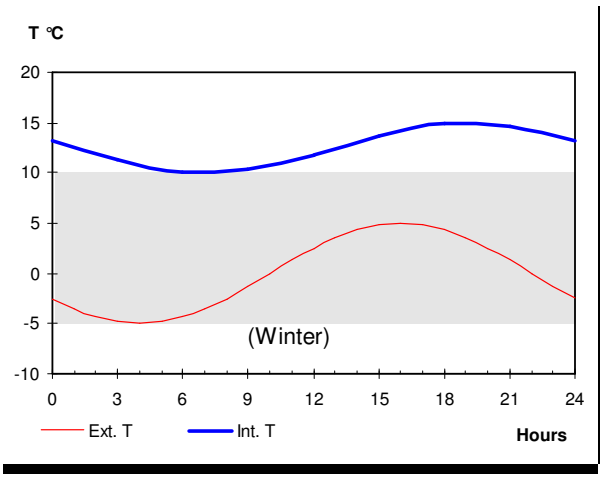


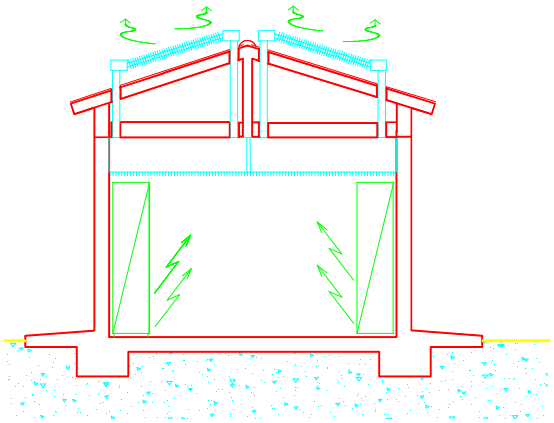




TYPICAL MAST MOUNTED CABINET







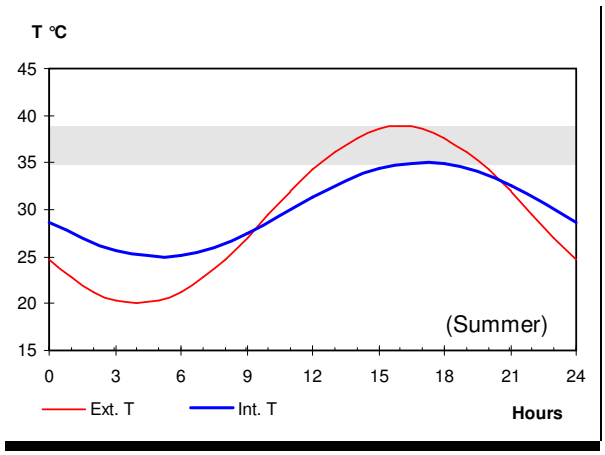
MASONRY HOUSINGS

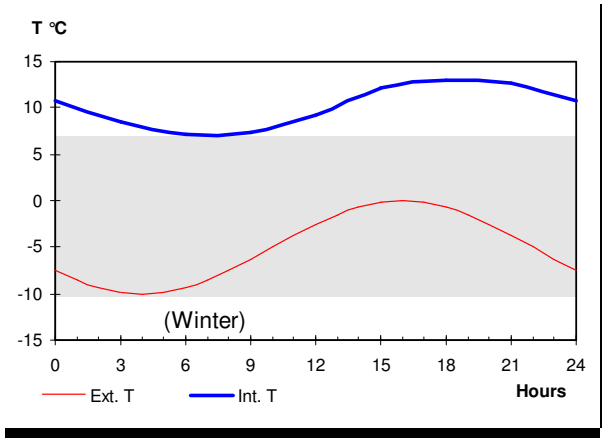
Note: Special systems for brickwork housings are developed according to the type of insulation and structure existing.

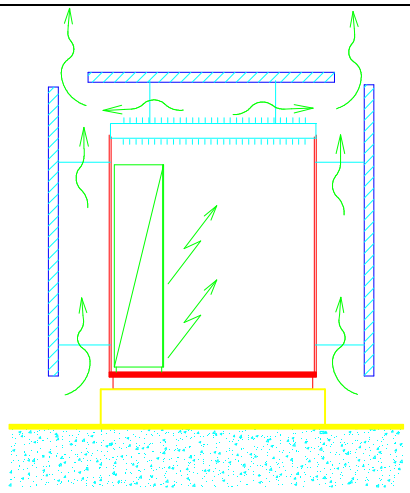
CABINET ~ 300W*

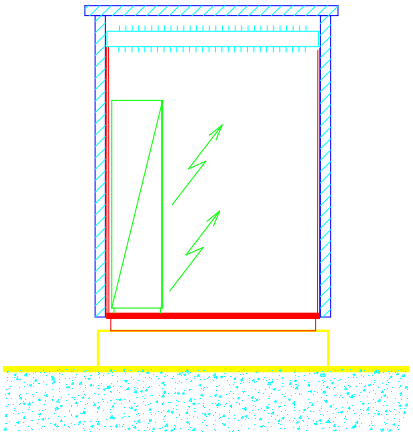
*The power is in reference to a cabinet that has ~4 sqm of external exposed surface.

Note The thermal result is proportional to the surface, to the heat exchanger characteristics and to resulting ΔT in winter and summer.









TYPICAL CABINET FOR CONTINENTAL CLIMATE *

Walls with variable insulation are designed when it is necessary to differentiate between the summer and winter thermal behaviour.

* *Patent by Enzo Celant in progress*

PASSIVE SYSTEMS WITHOUT STORAGE

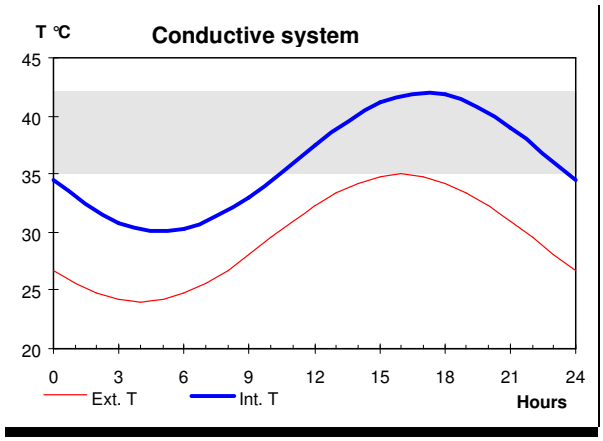
This is the most frequent application used for above ground shelters. The internal ambient is hermetic and separated from the external ambient by a smooth or corrugated aluminium surface for thermal exchange reasons.

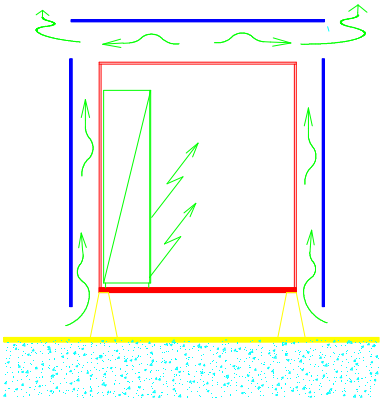
Note: When the maximum external temperature is near to the maximum internal temperature the same solution is still possible by installing a thermal mass.

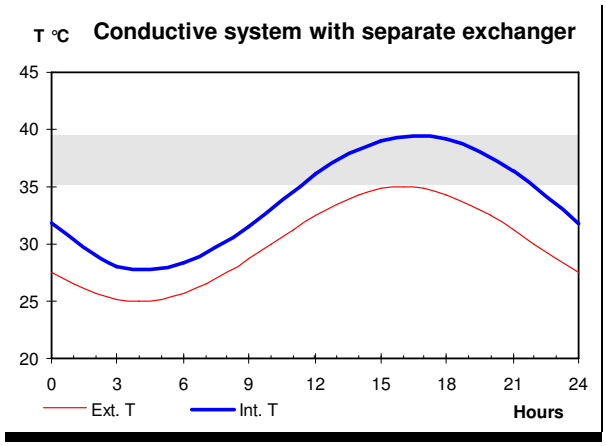
Amount of power that can be dissipated 400W ~800W*

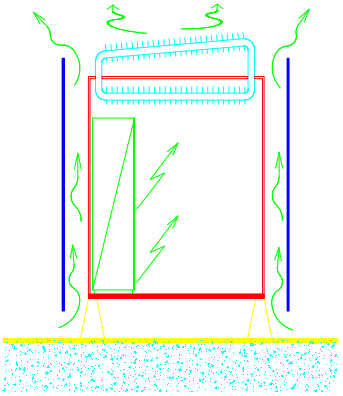
* The above-dissipated power refers to a standard module of 2.5 mt. in length and 1 mt. in width with a ΔT between 10°C and 20°C.

Walls with variable insulation are used when it is necessary to differentiate between the summer and winter thermal behaviour.

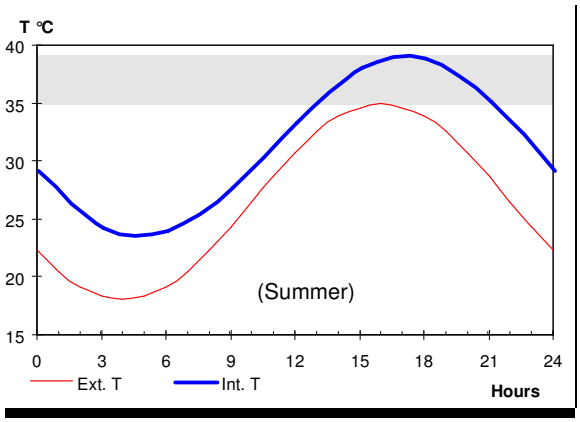


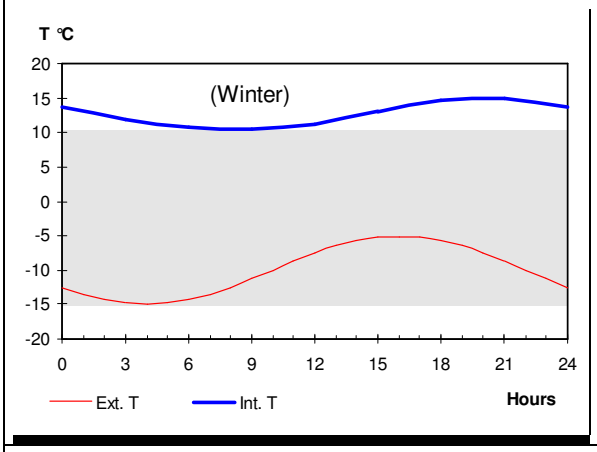


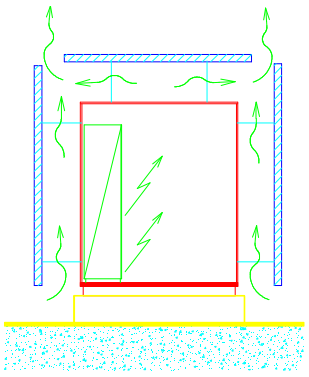


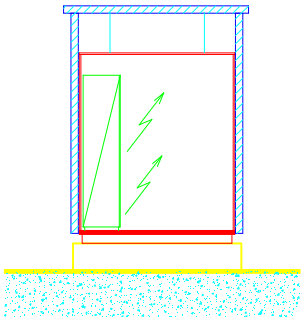


TYPICAL EQUATORIAL CLIMATE SHELTERS









TYPICAL CONTINENTAL CLIMATE CABINET *

The cabinet is equipped of variable insulation walls

** Patent by Enzo Celant in progress*

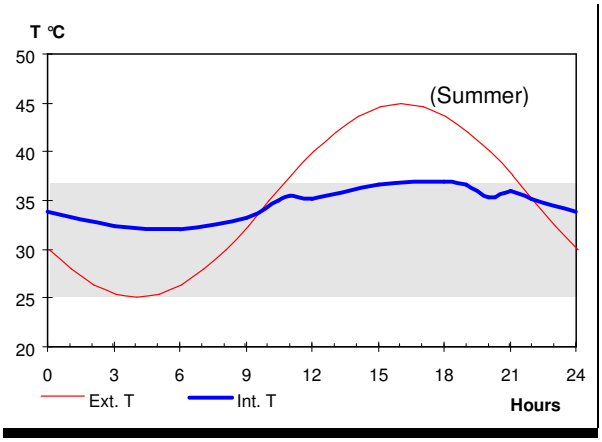
OTHER POSSIBLE APPLICATIONS OF THE SYSTEM WITHOUT STORAGE

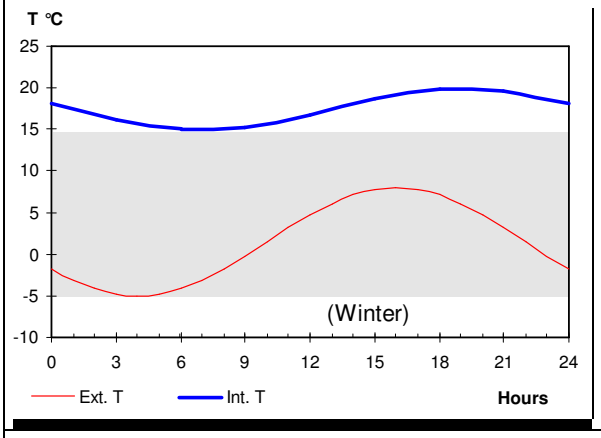
- Cabinet ~ 70W
- The power dissipation refers to an external exposed surface of approx. 1 sqm.
- Micro-repeaters ~ 100W
- Below ground

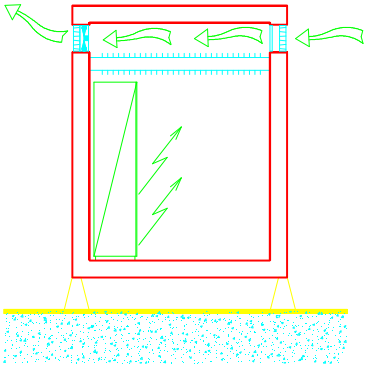
Without entrance doors/turrets - up to 200W
With entrance door/turrets - over 200W

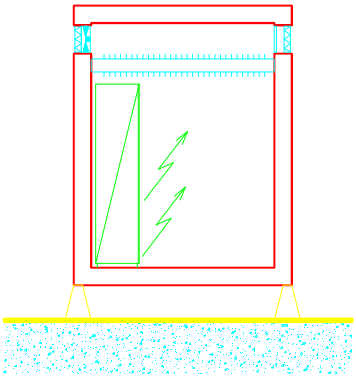
The power that can be dissipated is proportional to the surface of the container and it is possible to obtain an internal temperature lower than that of the outside ambient.

SEMI-PASSIVE SYSTEMS WITH STORAGE



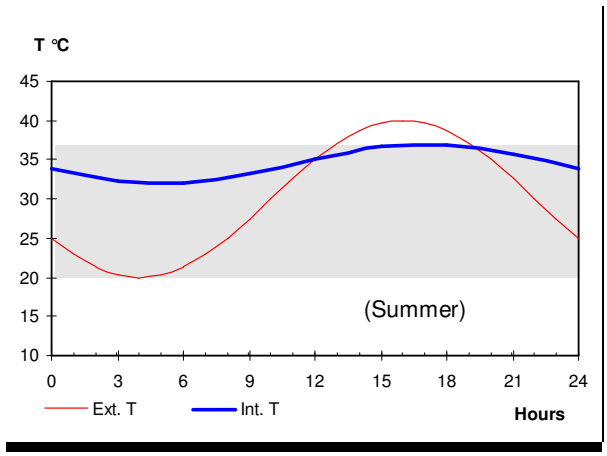


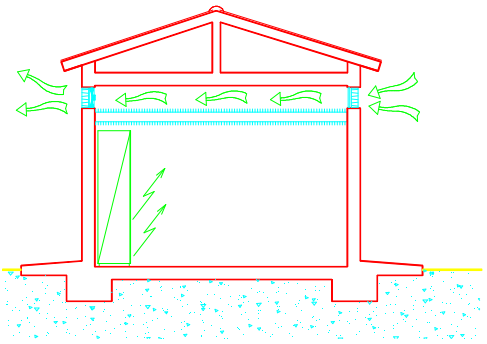


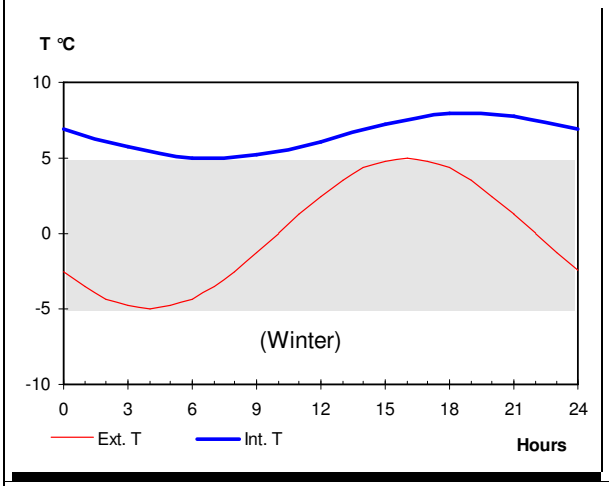


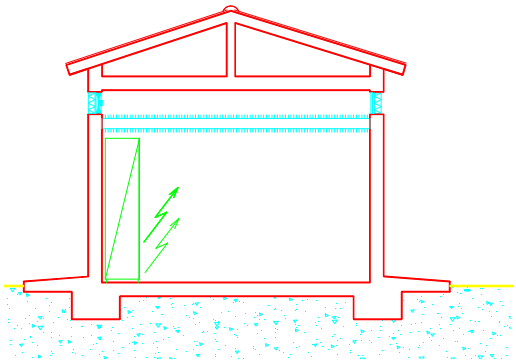
TYPICAL SHELTER FOR TEMPERATE CLIMATE *

** Patented by Enzo Celant, Marco Merletti*





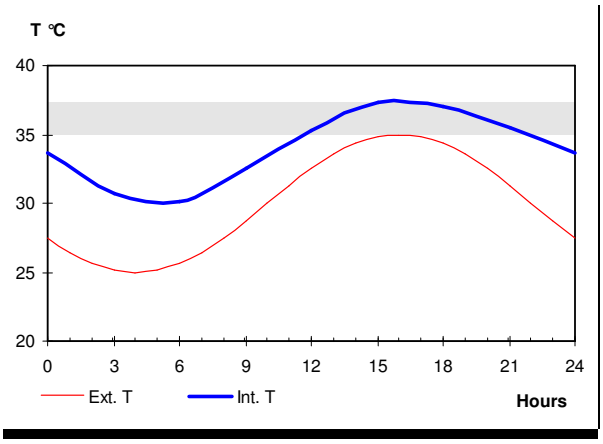


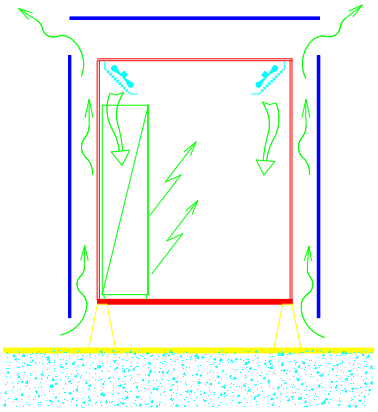


MASONRY STATIONS *

** Patented by Enzo Celant, Marco Merletti*

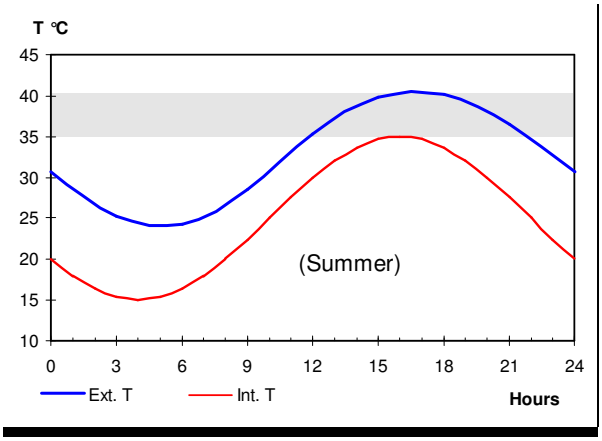
SEMI PASSIVE SYSTEMS WITHOUT HEAT STORAGE

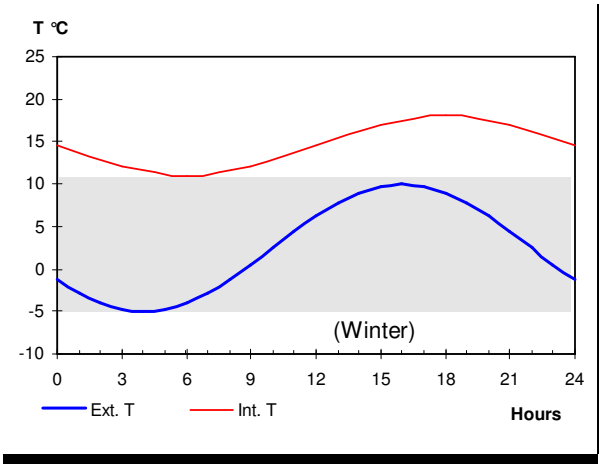


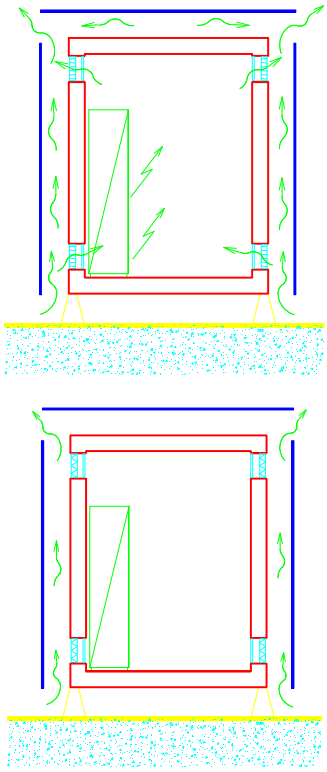


TYPICAL SHELTER FOR EQUATORIAL / WARM TEMPERATE CLIMATE

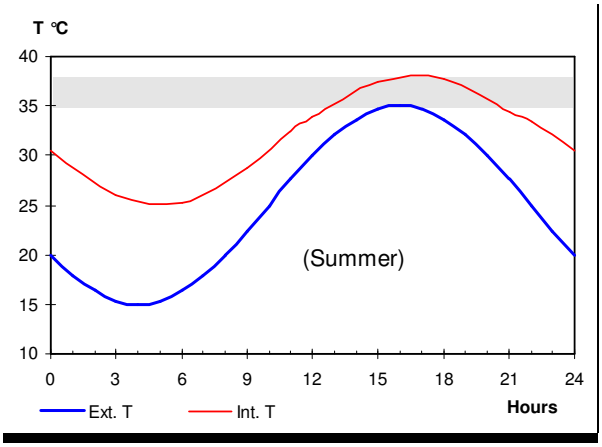
PASSIVE VENTILATION SYSTEMS

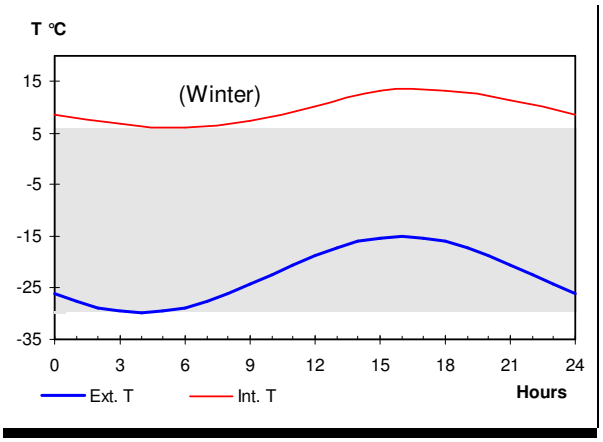


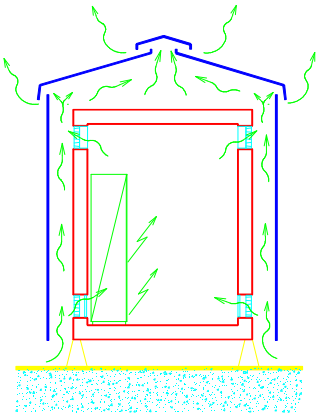


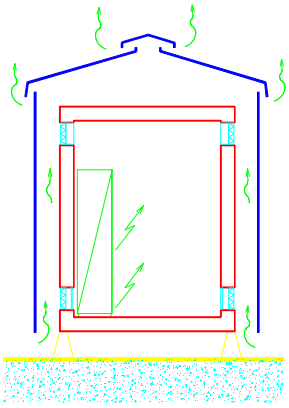


TYPICAL APPLICATION FOR TEMPERATE CLIMATE









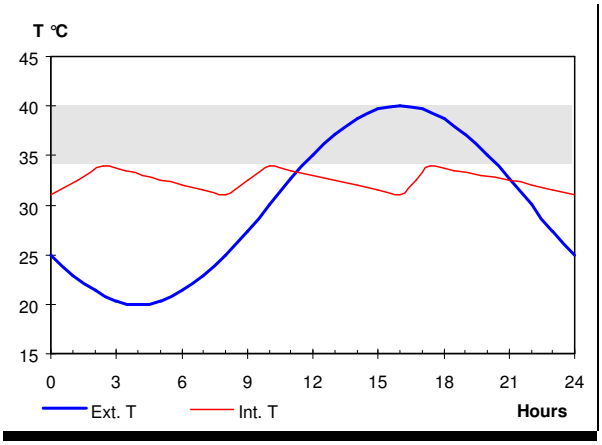
TYPICAL APPLICATION FOR ARCTIC CLIMATE

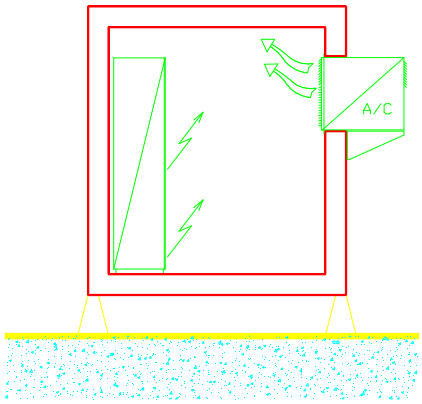
** Patent by Enzo Celant*

ACTIVE CONDITIONING SYSTEMS

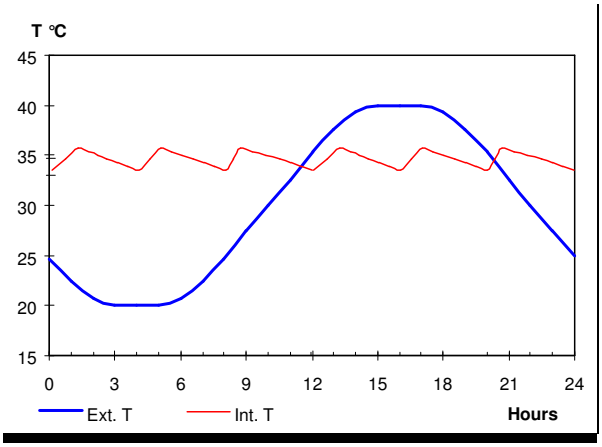
Conditioning is possible with all types of power dissipation.

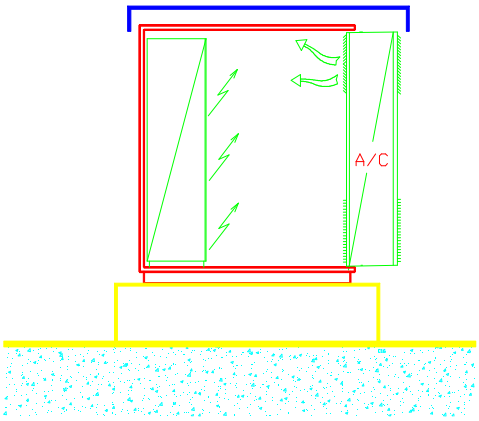
With this solution for each 1000 W dissipated the average power consumption is 600 W.



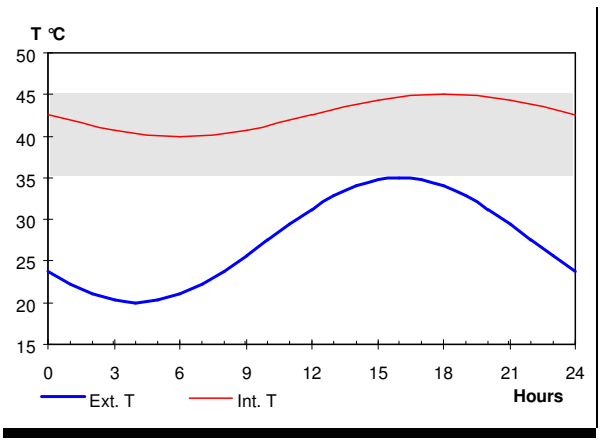


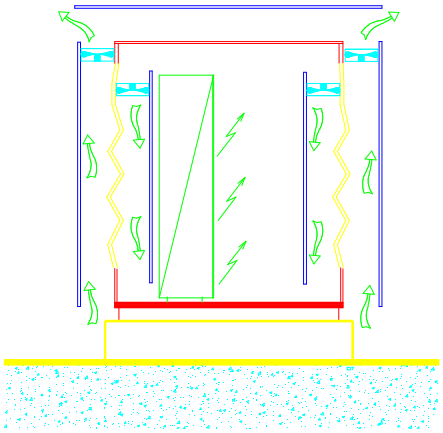
TYPICAL ACTIVE CONDITIONING SHELTER





TYPICAL ACTIVE CONDITIONING CABINET

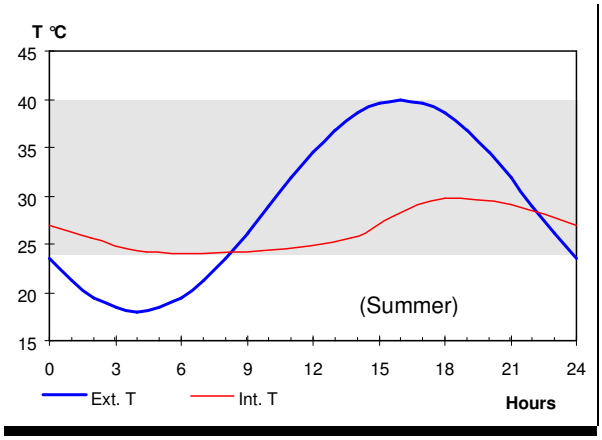


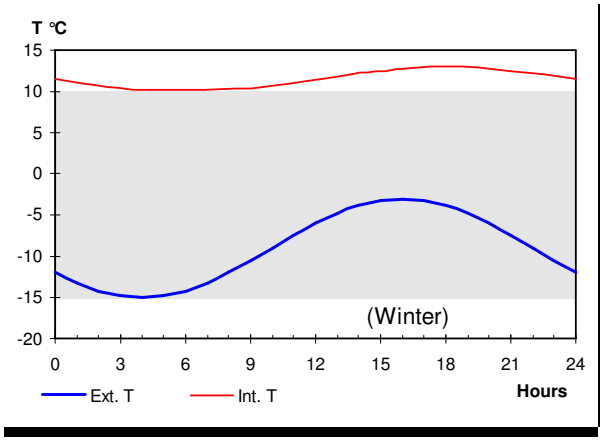


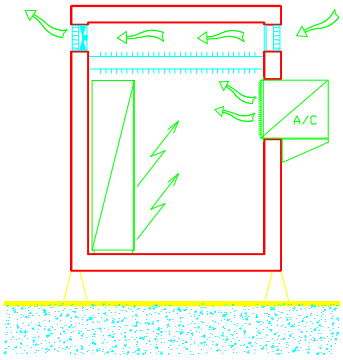
TYPICAL ACTIVE AIR/AIR EXCHANGERS CABINET

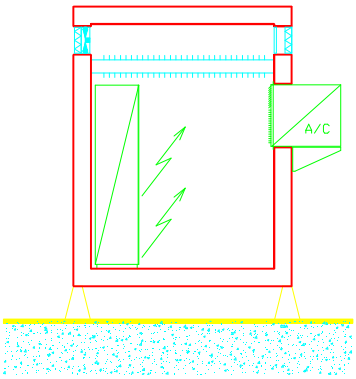
MIXED CONDITIONING SYSTEMS

To be analysed on a case by case basis. The power consumption over various periods without energy saving are similar to those indicated for the active types.









TYPICAL MIXED CONDITIONING SHELTER *

** Patented by Enzo Celant, Marco Merletti*

Below Ground Shelters

WITH ENTRANCE DOOR/TURRET
These may be passive or semi-passive with air to air exchangers and actively ventilated.

WITHOUT ENTRANCE DOOR/TURRET
Only hermetic.

Brick walled Stations

These are substantially actively conditioned with the possibility of being transform into semi-passive or hybrid conditioning.

7. AUXILIARY PLANTS AND SYSTEMS

Description and drawings of the various systems and fittings which, time by time, are to be included in a telecommunication station, will be treated in a separate manual.