Coyote House

Coyote House was custom built for someone with severe chemical, electrical and sound sensitivities. It was constructed using safe building practices developed in the local area over more than two decades.

Keywords: MCS house, less-toxic house, low EMF house, healthy house, design, shielding, Snowflake, Arizona, noise sensitivity, hyperacusis

The main design goals were:

- extremely good indoor air quality
- very low electromagnetic radiation
- very low noise levels
- low maintenance / low need for toxic maintenance
- reasonable cost
- normal appearance

These goals are accomplished by various design features, building practices and selection of materials, which are described in the following. A friend, who is a retired engineer, volunteered to design the house and oversee the construction

process. Local contractors with previous experience in MCS building were hired for all phases of the construction. The house was finished in 2007.

The general area

The house is located in a rural area in northeastern Arizona, that has low levels of air pollution, noise and radiation from cell towers, radio and TV transmitters. The area has attracted nearly three dozen people with extreme sensitivities, many of whom have had built similarly constructed houses in the immediate area.

Also in the vicinity is a four-unit rental housing development for people with MCS who are also of low income. This development was funded by the State of Arizona and is now managed by a non-profit housing organization.

The house is located on a 20-acre lot, with the nearest non-MCS neighbor being about half a mile away. It was intentionally placed between two small hills, to provide shielding against future cell towers.

The house is located in the high desert, at about 5900 ft (1900 m) elevation, which provides a moderate four-season climate.

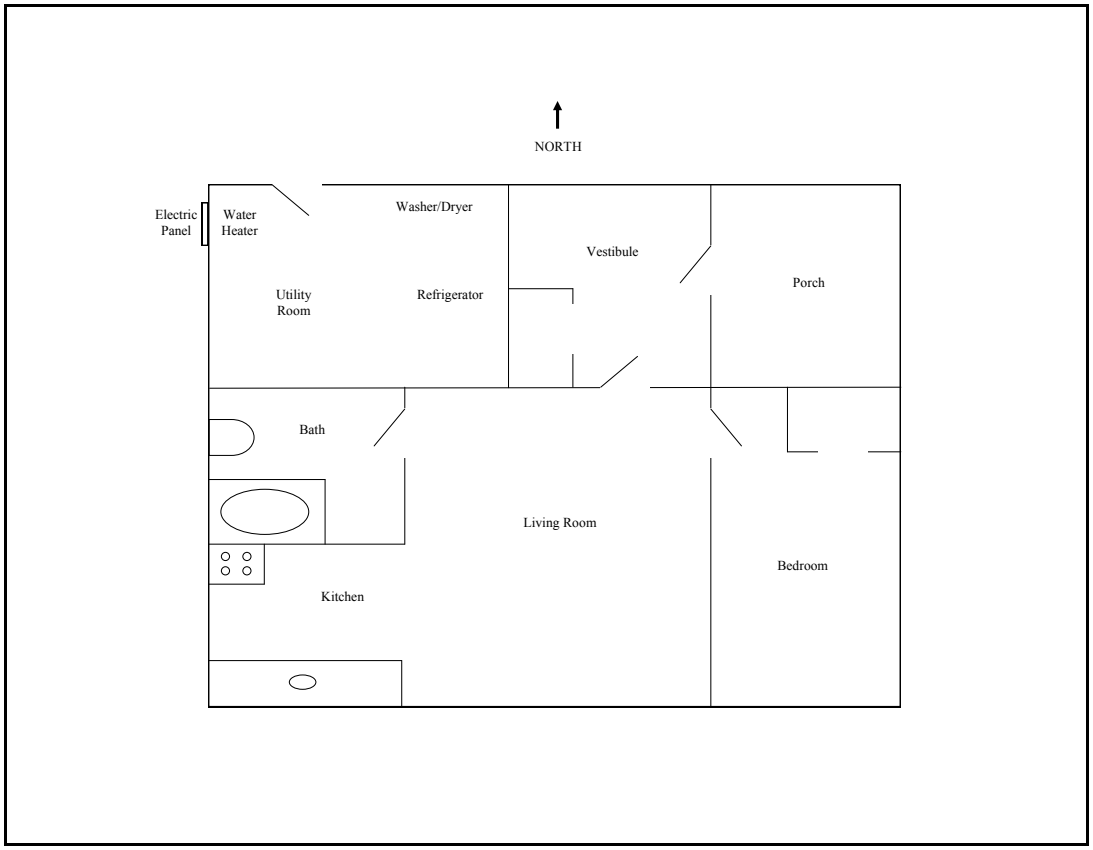
Building layout

The layout of the building has the bedroom at one end of the house, as far away as possible from sources of noise and electromagnetic radiation.

Many hours are spent in the bedroom every day, especially by people with fatigue. It is thus imperative to make the bedroom the most protected area of a house.

The kitchen and the utility room are placed at the opposite end of the house from the bedroom. This keeps the following appliances at the maximum distance:

- electric panel / utility service entrance
- refrigerator
- stove / hot plate
- washer / dryer
- water heater
- water softener



This layout also means that electrical wires carrying a high current are as short as possible and pass through the living areas of the house as little as possible. No wires pass through the bedroom.

The house is oriented east-west, with the living room on the south side so it is heated by the winter sun. A two-foot (60 cm) roof overhang blocks the summer

sun. This lessens the need for heating and cooling, which both saves money and reduces electrical exposures.

The porch is on the northeast side, so it is sheltered from the prevailing winds.

Foundation

The foundation is a concrete slab (monopour) directly on grade, with a vapor barrier underneath. Basements and crawl spaces are problematic for people with MCS as they very often become moldy, even in a desert.

The concrete has no additives, such as frost protectants, accelerants or fly ash. This meant the slab could only be poured in a frost-free period and it had to be wet cured under a tarp for three days. Additive-free concrete is now uncommon and some contractors refuse to work with it.

The perimeter of the concrete slab is insulated with foam boards ("blue board"). There is no insulation below the slab, which helps to keep the house cooler in the summer.

The outer shell

Steel panels are used for siding, as they are non-toxic. The finish is guaranteed for thirty years and does not require painting. This is important, as a person with MCS would have to leave the house during painting and perhaps for weeks or months afterwards.

The siding is mounted over horizontal lumber that is nailed to the studs, instead of toxic plywood. There is no plywood in this house at all.

Conventional American roofing typically has plywood sheets on top of the trusses, with tar paper and asphalt shingles over the plywood. This house uses a less-toxic roofing system that has been used for barn roofs for many decades and on MCS housing since 1988. It uses 2x4 lumber, which is attached horizontally across the trusses, so it looks like a giant ladder. These are called purlins.

The steel roof plates are then screwed into the purlins. This provides a very strong roof, which is virtually non-toxic and maintenance free.

All interior and exterior doors are steel, which came pre-primed and were not painted. The windows have aluminum frames, with a built-in thermal break. Window frames of wood or vinyl are not acceptable, due to the materials and the needed upkeep.

All outdoor trim is of steel, or wood wrapped in steel, to avoid any use of paint.

All outer surfaces are steel plates, even the trim. This omits the need for any toxic paint.

Plumbing

The pipe from the well is hard-plastic PVC, which was glued together using a special method that exposes less excess glue to the water stream.

The in-house plumbing is copper. The owner would not have been able to tolerate water coming through soft plastic, such as PEX, which is the most common product nowadays.

Teflon tape was used to connect plumbing fixtures instead of "pipe dope," which contains biocides.

The pressure tank has a bladder of ethyl vinyl, which is better tolerated than the typical rubber bladder.

Drinking water is supplied through a reverse-osmosis filter system.

Insulation

Formaldehyde-free fiberglass batts were installed in the wall cavities and the attic. The batts came with a brown paper backing which was removed and discarded as it was odorous and not needed.

The inside wall surfaces

The walls are standard gypsum drywall, with a non-toxic joint compound (Murco M-100). The drywall sheets were mounted with the bottom edge about half an inch (1 cm) above the floor to prevent wicking and mold in case of a spill (the gap was covered by the baseboard).

The walls and ceilings were then sealed with aluminum foil, which was attached with fungicide-free wheat wallpaper paste. The gaps between the aluminum strips were covered with aluminum tape. The foil acts as a moisture barrier, besides sealing in the fumes from the materials in the walls (the local building code requires the use of a moisture barrier).

All wall boxes and wall penetrations were sealed using aluminum tape and a less-toxic spray-in foam (Great Stuff brand). This makes the walls air tight, so no fumes from the wood, insulation, drywall or wiring enter the interior airspace.

The aluminum walls were washed to remove any manufacturing oils and oxidation. Then the seams were spackled using a non-toxic custom clay putty.

The walls were painted using a non-toxic preservative-free clay paint, which was custom made on-site.

Tile work

The floors are ceramic tiles. Cut tile is also used as baseboards at the bottom of each wall, as well as around doors and windows, to minimize the use of wood products.

All surfaces in the bathroom are tiled, including the ceiling, to prevent molds, and because the custom made clay paint is not moldproof.

Tiles cover the walls around the kitchen counter and the stove. This is to catch any splashes, as clay-painted walls cannot be washed.

The floors are all tiled.
Tile is also used for the baseboard and the trim around the doors.

The cooking area has tiles on the wall to protect the clay paint against splashes.

Custom mixed grout and thinset were used, as the commercial blends have problematic additives. As the custom mixes were not as strong as the commercial products, degreased hardware cloth had to be used under all tiles on walls and ceilings. This added much labor. The grout was wet cured for three days, under a plastic tarp, as it had no chemical additives.

Cabinets

All-steel cabinets with powder-coated paint were used in the kitchen. Conventional kitchen cabinets were not acceptable, as they all contain problematic materials.

The countertop was constructed of three layers of HardiBacker cement board, with ceramic tiles on top.

Low-EMF features

The building layout keeps the electrical appliances as far away from the bedroom and the sitting area as possible. The breaker panel is located on the outside wall of the utility room, which minimizes the length of the wires carrying a high current (such as for the water heater and stove). The water heater is located in the corner of the house, so it has the maximum possible distance from anywhere a person may spend much time.

The electrical service to the house comes via an underground cable, which emits lower radiation than aerial lines.

The electrical meter is placed on a pedestal, about 70 ft (20 meters) from the house. The transformer is yet further away, also due to EMF issues, as well as noise.

The electrical meter is placed on a pedestal away from the house, to minimize EMF.

Low-EMF electric baseboard heaters are located to minimize EMF exposures. The owner does not use the bedroom heater while sleeping.

The well is placed on the same side of the house as the electrical panel, meter and transformer, to prevent stray voltage/ground currents from passing under the house (as they go between the various ground rods).

The electrical wiring is twisted to reduce the magnetic radiation. A brand of three-conductor (12/3) ROMEX cable was found that was already twisted inside the sleeve. The extra (red) wire was simply not used. The typical magnetic level is 0.02 milligauss (2 nT).

The foiled walls provide shielding of the electrical fields from the wires. The typical electric field in the house is 1 V/m (a normal house typically has 10 to 50 V/m).

Kill switches are installed in the bedroom, to isolate the room from the electrical system. These switches disconnect both the "hot" and the neutral wires.

The house has electric baseboard heat, due to cost restrictions. Low-EMF SoftHeat units from Cadet are used. The heaters are located to limit radiation exposures as much as possible. The owner does not use the bedroom heater while she is in there.

The passive solar heating and cooling features of the house also provide for lower EMF exposures. There is less need for heating in the winter, and cooling in the summer.

There is no air conditioning in the house, as such units are not tolerable due to electromagnetic radiation, noise and fungicides. The summers are mild enough that air conditioning is not necessary, though if the owner could tolerate an air conditioner, she would have one.

Because it is an all-metal house that means any sources of wireless radiation inside the house (wireless phones, Wi-Fi, etc.) will bounce around and create much higher levels of indoor electrosmog than if it was a regular non-metallic house. However, the metal also provides shielding against wireless radiation from outside the house.

Shielding against cell phone base stations, etc.

The house is located in a low-radiation area, though the ambient levels have risen since the house was built. The ambient levels outside the house was in 2015 measured to be about 2 uW/m^2 (the levels in the nearest city, Flagstaff, were about 1000 uW/m^2).

Knowing that the ambient levels would rise in the future, the owner wanted a house that shields against cellular towers and other microwave pollution. This author tested the house and found it to provide about 30 dB (i.e. a thousandfold)

reduction of microwaves at 1900 MHz, which is surprisingly good. The house shields so well that there is very poor radio and cell phone (3G/4G) reception inside. Reception is really only possible near the windows, which are the weakest part of the shielding. Reception improves dramatically if a window is opened.

The house uses two layers of shielding: the steel siding and steel roof is the outside layer, while the aluminum foil on the inside is the inner layer.

The weakest areas are the windows, as they only provide a single layer of shielding. The windows have metallized low-E glass and aluminum frames. The foil on the walls was extended to be in direct contact with the window frame on all four sides (under the tiled window sill, and behind the tiles on the side and above).

Windows of this type usually shield about 20 dB, but these manage 30 dB for some reason (as tested on both bedroom and living room windows).

The entrance door is made of steel and the wooden frame around the door is wrapped in steel plates.

The house has no shielding of the floors, other than what is provided by the concrete floor and the soil underneath.

The location of the house between some small hills provides modest additional shielding against distant transmitters (about 10 dB).

Low noise features

The rural neighborhood the house is located in is far from most sources of noise, such as highways and airports. The area has unusually low background noise levels, which have been measured to be only 22 dBA ($L_{A,90}$).

The walls between the utility room and the rest of the house are insulated to reduce sound transmission. To reduce noise in the main house, all appliances are located in the utility room, including the refrigerator. The owner is so noise sensitive that she cannot tolerate the sound of her refrigerator, day or night.

There is no door between the main part of the house and the utility room. The owner has to go outside, then back into the utility room to access the refrigerator and the washing machine.

The kitchen sink is of porcelain instead of steel, as the owner cannot tolerate the noise of running water in a stainless steel sink.

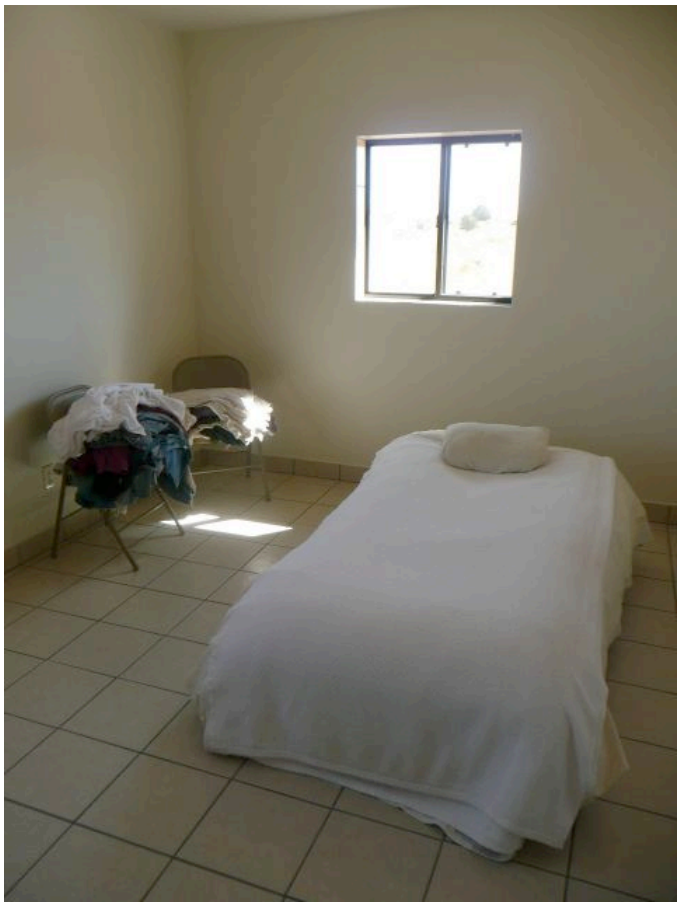
The transformer is located about 150 ft (50 meters) from the house to minimize the hum.

Wheelchair accessibility

Even though the owner was in her thirties when the house was built, it was prepared for her to live there in her old age.

The house is prepared for wheelchair use by having all doors 3 ft (1 m) wide and with low or no thresholds. The bathroom sink is on a wheelchair-accessible pedestal.

The living room and kitchen



The bedroom

The bathroom with tiled walls and ceiling to prevent mold growth

The utility room is sound insulated as the owner is very noise sensitive. Even the refrigerator is placed here, to prevent noise in the house.

The electric water heater (right) is in the corner of the house, right next to the electrical panel (on the outside) to minimize radiation.
The blue iron filter is on the left.

More information

This website has several other articles about healthy house design, construction, shielding, etc. They are available through www.eiwellspring.org/saferhousing.html.

2013 (updated 2016)