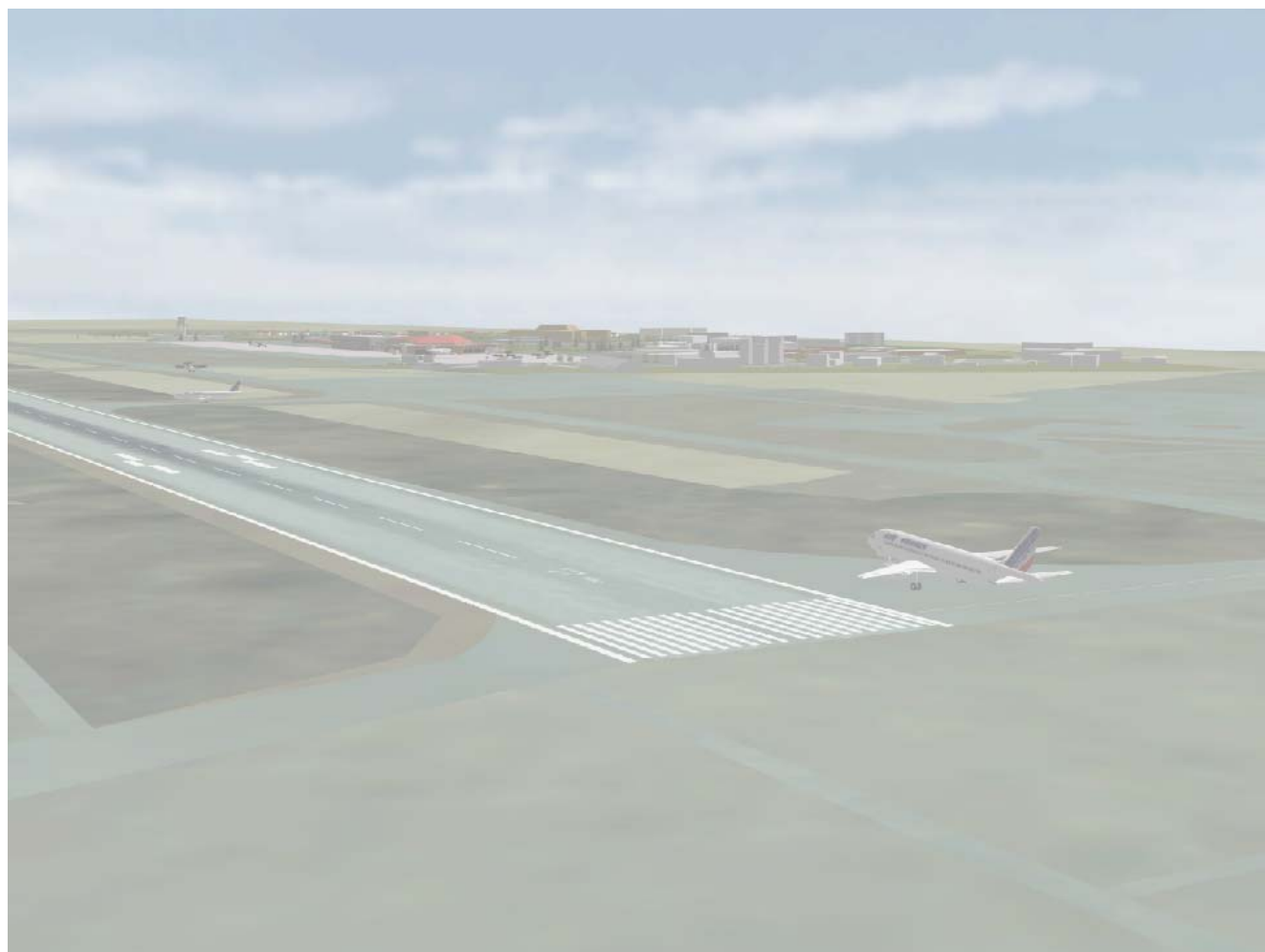




Contract N°: AST3-CT-2003-502817

Enhancement with physical data



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1 Introduction

1.1 Aim

This work package's main goal was the enhancement of geometries with physical attributes. Every surface in the vicinity of Blagnac airport should be electromagnetically characterized in a great span of frequencies, ranging from some hundred MHz to tenths of GHz. This is because we need to predict how the electromagnetic waves will be attenuated through or after reflection.

1.2 Report content

The materials gathered can be classified in several categories.

1.2.1 Soil

A very extensive database of soil materials has been accumulated. These soils span a gamut of various soils that might be occurred in nature, in different geographical regions. Clay, sand and silt, in various percentages can constitute a variety of soils. Electrical properties of a randomly chosen soil composition do base upon the percentage of each basic material. Additionally, volumetric moisture content and temperature constitute 2 key factors that differentiate the electrical properties of soils.

1.2.2 Water and snow

In this section the dielectric properties of water at various temperatures(1.5°C, 5°C, 15°C, 25°C, 35°C) and snow in various phases(-20°C, -6°C, fresh snow, fresh snow followed by rain). In our case, there are no water territories like lakes or sea near the airport, but in a rainy day many of the areas could be considered as layers of material and water in a specific temperature.

1.2.3 Organic matter

Within this section a list of organic materials, mostly used as construction materials and interior building facings will be presented. We have managed to acquire dielectric properties versus frequency for a broadband range of frequencies.

1.2.4 Glasses and ceramics

These types of construction materials are used as outside facings for airport buildings and vehicles. Their electrical dielectric properties are a function of their composition. Glasses can contain traces of various metals and organic and inorganic materials, therefore exhibiting a divergent variety of dielectric constants and losses. Ceramics are indoor and outdoor building materials with very stable dielectric properties in a great range of frequencies. This stability can be proved beneficiary for an engineer because extrapolation of data to higher or lower frequencies can be applied.

1.2.5 Plastics

Plastics are ubiquitous in our contemporary living and can be used everywhere. Knowledge around plastics could be very useful for ground penetrating radar imaging, where pipe leaking can be identified.

1.2.6 Composite materials (concrete, asphalt...)

These types of materials are very difficult to characterize, due to their composite nature. They are made of various organic and inorganic bi-products, water and different type of soils. There cannot be a rule of thumb to safely extract information about their dielectric properties, because they are temperature, moisture, time and composition dependant. Only laboratory environment can firmly guaranty stable behaviour.

2 Soils

Much of the information that will be found in this report have been measured by the US Army Corps of Engineers, a research organization dealing with soil characterization. In the scope of SIRENA we choose to analyze the dielectric properties of 3 soils in different moisture and temperature conditions, as can be seen in the following table (see Table 1).

Table 1 : Selected soil samples

Physical characteristics of Soil Samples			
SAMPLES	Percentage by weight		
	Percentage Sand	Percentage Silt	Percentage Clay
Clay, Light Gray	2	22	76
Clay, Grey	1	48	51
Clayey Silt, Brown	4	89	7

For two temperatures of 10°C and 20°C and two moisture percentages the Soil properties vs. frequency and moisture was established.

It is deduced that the higher the moisture percentage the greatest the soil losses.

3 Water and snow

We hereby attach the dielectric properties of water in different states, since diffraction from water could potentially be a subject of research within the frame of future EMC scenarios. In addition, we present data dealing with salt water properties.

Snow on the other hand, is a very common water state in northern geographical regions including Blagnac airport. We present the electrical dielectric properties of snow, according to modified Debye-like model for 2 different water contents of 0% (dry snow), and 10%.

4 Organic matter

Like other building materials, the relative permittivity and loss tangent of wood depends on a range of different factors. These factors include the type of wood involved (tree species), the wood density, water content, the temperature, frequency of operation and any special chemical treatment applied to the wood. The latter is done in order to impart to wood special properties like biological resistance to water absorption. It has been found that as moisture or water content increases, electric conductivity increases and the behavior of saturated wood approaches that of water.

Apart from solid wood boards, other important wood based materials used in buildings are fibreboards and particleboards. Fibreboards are composed of wood chips or plant fibres bonded together and compressed into rigid sheets. During the production of fibreboards the wood is subjected also to thermal and moisture treatment. All these processes affect the dielectric properties of fibreboards.

Similar to fibreboards are particleboards, which are made of wood fragments and are mechanically pressed into sheet form and bonded together with resin. In the particleboard case, dielectric properties depend also on the kind of resin used during the particleboard construction process.

5 Glasses and ceramics

5.1 Glasses

Glass usually occupies a significant area of the external wall of buildings and in most cases will provide a relatively low loss path to electromagnetic waves. This makes the investigation of glass equally important to the commonly used construction materials such as concrete and bricks.

The electrical permittivity of glass has been found to vary strongly with glass composition but not with frequency. Furthermore it has been found that permittivity changes with increasing temperature and this is based on the fact that at higher temperatures the ions are more mobile.

5.2 Ceramics

The most commonly used ceramics in buildings are bricks. At least 5 types of ceramics fully characterized.

It can be deduced that for zero or small volumes of absorbed water, the real and imaginary parts of the complex permittivity between 0 and 9 GHz are almost the same for all brick types.

6 Plastics

At this stage of the project, we have chosen to omit this category for the materials database, since it was not required in our simulations.

7 Composite materials

7.1 Concrete

Concrete is made by adding water to a mixture of cement, sand and coarse aggregate. Hydration takes place between the water and cement producing a matrix of compounds known as cement paste. It is impossible to safely extract absolute permittivity and $\tan\delta$ values since concrete is time, temperature and moisture dependant.

7.2 Asphalt

Composite materials like asphalt are mostly characterized in narrow bandwidths.

8 Conclusion

At this stage of the SIRENA project, the dataset provided by ICCS, in collaboration with ONERA and OKTAL SE is very satisfying regarding to the task of enhancement of Blagnac mock up with physical properties.

Moreover, this dataset is suitable for most airport environment simulations, and also more generally for most outdoor environments.

The present report will be upgraded once Blagnac mock-up is enhanced with the materials database.

9 Annex

The excel file named WP4.3_materials_properties_database.xls contains the technical dataset annexed to this report.