Thanks to the hard work of a few, Natural Hydraulic Lime (NHL) has become one of the materials of choice for restoration/preservation projects and natural building construction in the United States. Suddenly realizing the great potential of NHL in the US, and feeling the economic hardship abroad, several European manufacturers have begun to break into the U.S. marketplace to compete with the more-established, well-known suppliers. Unfortunately, all NHL’s are not equal in performance and quality. Adding to the confusion, some manufacturers are offering artificial Hydraulic Limes, calling them HL’s and presenting them as an equivalent to NHL… Therefore, what should one look for when selecting a manufacturer?

DEFINITIONS:
It is important to understand the meaning of the acronyms used when selecting a lime with hydraulic properties (setting under water and by reaction with CO2 in the air):

• NHL: Stands for Natural Hydraulic Lime (EN-459). The hydraulic properties EXCLUSIVELY result from the chemical composition of the raw material. No additions are allowed.

• HHL: Stands for Hydrated Hydraulic Lime (ASTM C-141). It is the US equivalent of the European NHL.

• HL: Stands for Hydraulic Lime (EN-459). Consists of lime AND other materials such as cement, blast furnace slag, fly ash, limestone filler and other suitable materials. This is NOT a NHL!

• FL: Stands for Formulated Lime (EN-459). Consists mainly of hydrated lime and or NHL with added hydraulic and/or pozzolanic material. It is identical to HL but its composition must be declared on the CE marking.

• PHL: Stands for Pozzolanic Hydraulic Lime (ASTM C-1707). Very similar to HL or FL. Consists mainly of hydrated lime with one or more pozzolans with possible inclusion of inert filler. When cement, even traces, is present (can be up to 20% of binder weight), it has to be labeled as “PHLc”.

NORMS AND STANDARDS

Both standards have their qualities and flaws:
EN-459: This norm is a very extensive and elaborate document. It is very precise and strict in regards to the chemical and physical qualities of the product. It is the most referenced document as all NHLs come from Europe and are supposed to comply
with its requirements. However, the classification by strength (NHL 2, NHL 3.5 and NHL 5) is far from perfect and can be misleading: an NHL 2 should have—when tested in accordance with EN-459-2—a compressive strength between 2 and 7 MPa; an NHL 3.5 between 3.5 and 10 MPa; and an NHL 5 between 5 and 15 MPa. In theory, this gives a manufacturer producing an NHL at 4 MPa the opportunity to sell the same product under two different denominations: NHL 2 and NHL 3.5, or an NHL at 5 MPa as an NHL 2, 3.5 or 5!!! This can mislead the specifier who believes to have 3 different products with different performances.

**ASTM C-141:** This document is a lot more succinct than its European counterpart and uses a different name: Hydrated Hydraulic Lime or HHL, instead of NHL. However, its main quality is to complete the European Norm where it is needed: We previously described the confusion inherent to the classification. In 9.2, it states clearly that “The producer SHALL STATE the compressive strength, when tested in accordance with 11.6, at the age of 28 days.” This should allow the specifier to have a clearer understanding of the performance of the product. However, the specifier should require test data at one or two years as “Hydrated Hydraulic Limes will gain considerably in strength over time” (up to 90% of final strength being realized at only 12 months).

A second and very essential quality of C-141 is to require that the product to be reworkable as the hydraulic portion of the HHL is belite (larnite) and should minimize the formation of alite (like in Portland cement, which cannot be reworked). This should eliminate “artificial” Hydraulic Limes based on ordinary hydrated limes and clinker cement.

In conclusion, the specifier or end-user should require a strict conformity to both standards as well as all technical and testing data extending to a minimum of one year.

**MISLEADING AND ERRONEOUS INFORMATION**

Unfortunately, one cannot rely blindly on the probity of certain
manufacturers. Sometimes a short investigation will reveal practices leading to a misrepresentation of the product.

Here are some examples:

• A main manufacturer from Italy does not disclose the origin or the nature of its raw material. However, at the manufacturing plant one can only observe the presence of silos...hydrated lime, white cement or...? These products are sometimes shipped North to Belgium or Great Britain whereupon they take on a new identity and can be further blended, becoming a new “lime or NHL based” product.

• Another European producer, from Portugal, whose main activity is to produce cement, was only manufacturing, until recently, what they called a NHL 5. The testing data provided at the time would not have allowed for this product to be classified as a NHL with the revised EN-459. Miraculously, these figures have changed in order to appear to comply with the standard, at least on paper. Another miracle occurred when, suddenly, they discovered that they could also produce a NHL 3.5! Although forbidden, wouldn’t an addition of hydrated lime to an NHL 5 produce a product mimicking a NHL 3.5? Doubting the claims and conformity of such products, further testing has been conducted by a third party. Some results are, nonetheless, troubling. For instance, EN-459 requires the soundness (expansion) not to exceed 2 millimeters. In this case, testing shows an expansion 2 to 3 times above this limit. Excessive expansion translates, in a mortar or plaster, by an increase in volume (creating cracking, delamination, brittleness) and formation of “pops and pits” caused by the hydration and expansion of un-hydrated lime or lime impurity reaction products present in the hydrated lime. This translates into the appearance of surface defects (like small craters) in plastering application. Furthermore, these NHL’s cannot be reworked as specified in C-141.

• Yet, a British producer, mainly known for the production of NHL 2, did not succeed as well when they offered what they called NHL 3.5 and NHL 5. They finally abandoned this production but not the distribution. By simply entering into an agreement with the previous producer from Portugal, the product was repackaged, and now distributed under its own label.

• Closer to us, here in the Eastern United States, a manufacturer offers a Hydraulic Lime supposedly complying with ASTM C-1707. He defines his product as a Pozzolanic Hydraulic Lime or PHL. A closer look at the product shows that, in fact, GGBS (Ground granulated blast furnace slag) instead of pozzolans is inter-mixed with Hydrated Lime making it non-complying with the Standard. However, the use of GGBS in a mortar reduces dramatically its porosity and, by consequence, its permeability. The slow increase in mechanical strength may lead the manufacturer to misstate its final strength if testing data at 1 and 2 years is not provided. Furthermore, the slower hydration process makes its use problematic and tricky if the mortar dries before full hydration of the GGBS.

• In the state of Arizona another manufacturer pretends to comply with ASTM C-1707. However, his product is presented as a PHL (which cannot contain any Portland cement) when, in fact, the presence of white Portland cement makes it a PHLc.

Others (quite a few as a matter of fact) are playing with words, rendering [ed. - no pun intended] the end-user ill educated about lime, believing that he is purchasing a “true” lime product. The most common trick is the use of the term “lime-based.” The real meaning of these words is a product based on lime but intermixed with other ingredients. For example, a Portland cement added to lime can be considered a “lime-based” product. A true and authentic lime will always be referred to by its manufacturer as a lime product (hydrated lime, natural hydraulic lime, lime putty, etc.) and never as a “lime-based product.”

Conclusion:

When confronted with the task of choosing the best product for a lime project, one should:

• Look at the history of the manufacturer and the history of each product. Newly introduced products should be approached with caution as defects or flaws can take years to develop

• Ensure that the lime complies with ASTM C141 and EN-459 by requiring that the manufacturer provide the documentary evidence, complete with test results.

• Require detailed testing data with real numbers, not only to check the conformity to standards, but also showing the performances of different mixing ratios, and for a minimum of one or two years.

• Select a manufacturer that will provide technical assistance, guidance, and recommendations. Each project is different and the manufacturer’s contact is essential when looking for the best performance.

• Verify that the manufacturer or his representative is insured and provides the necessary warranties.

With a long and accomplished history as an architect, Michel Couvreux is credited with having revived the use of natural hydraulic lime in the United States since TransMineral USA re-introduced it back into this country in 1997. He doggedly pursued the approval process of natural hydraulic lime for acceptance in the ASTM standards, lime category ASTM C141 Standard Specification for Hydrated Hydraulic Lime for Structural Purposes. http://www.limes.us/