Achieving Sustainability of a Roofing System

By Tom Hutchinson, AIA, FRCI, RRC

Over the past two decades, responsible roofing professionals have sparked a drive toward greater interest in and adherence to the concept of sustainability. Beyond the desire to improve return on investment on such a significant part of the building envelope, adopting roof systems to fit within environmental parameters has great resonance in modern times.

Perhaps the most cogent description of the concept came from Gro Harlem Brundtland, former prime minister of Norway, in a 1987 report to the United Nations Commission on the Environment and Development. In it, Brundtland defined environmentally sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In the roofing industry, the essence of sustainability is long-term performance. This anticipates service lives of 30 years or more for roofing systems.

As roofing professionals applied the concept of sustainability to their construction and reroofing projects, they learned that several key areas provided opportunities for improvement. These areas were identified by the CIB (International Council for Research and Innovation in Building Construction) Working Commission W.83 or RILEM (International Union of Testing and Research Laboratories for Materials and Structures) Technical Committee 166RMS (CIBW.83/RILEM166RMS). This author was a cochairman of the committee.

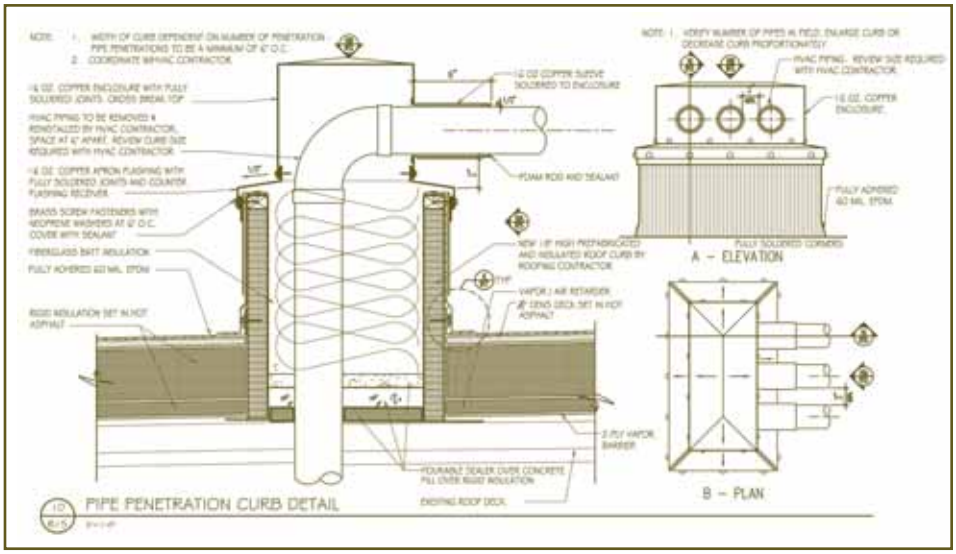
The areas identified include:

1. Minimize the burden on the environment by responsible use of materials;
2. Conserve energy by improving thermal efficiency of roofs; and
3. Extend roof lifespan by improving long-term performance.

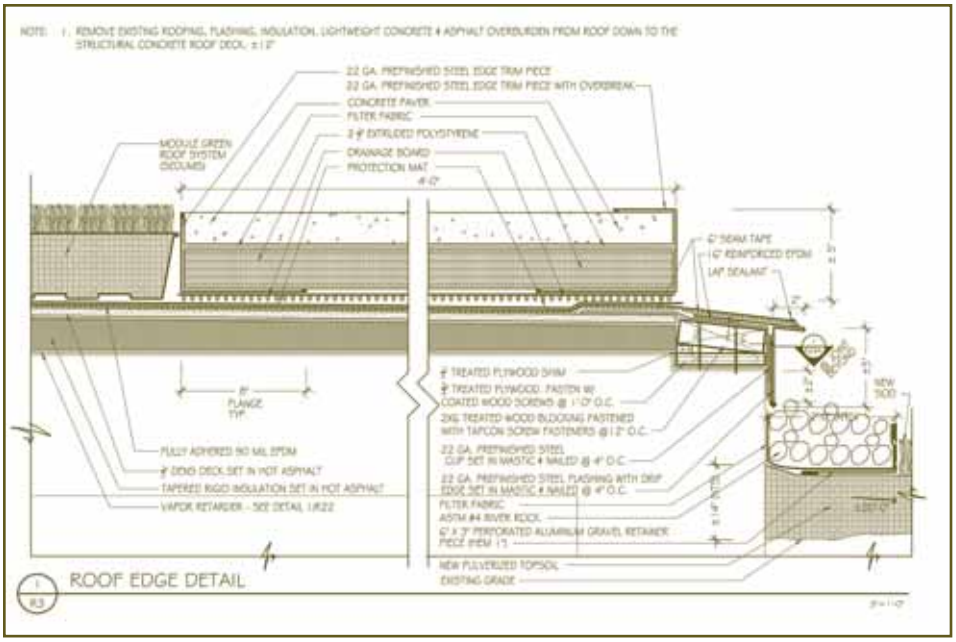
We will focus our attention primarily on the third tenet; in particular, how roofing professionals and building owners can extend the lives of their roofing systems, specifically those using single-ply membranes, during and after installation.

The comments that follow should be viewed as a primer to spark greater interest in and adoption of the methods that achieve sustainability. While it is not a complete and definitive guide, we believe it does address some areas of great interest and opportunity for roofing professionals.

Certainly much can be done to ensure sustainability before bringing in the construction crew. Gaining a consensus among all parties as to the goals and performance expectations is an important step, as are factoring in the budget for the project, deciding on the specific characteristics of the building, and determining its geographic location.



Detail 1 – A good example of how to clearly outline the structure of a roof, its components, and instructions with good visual information. Courtesy of Tom Hutchinson.



Detail 2 – The components of a sample roof system that applies the philosophy of sustainability. Courtesy of Tom Hutchinson.

Material Selection & Design

Choosing the appropriate materials is certainly a major factor in the procurement of a sustainable roofing system. While many products on the market advertise their ability to produce sustainability, only quality materials with proven records of long-term performance should be used. Materials and systems that offer the promise of performance but lack the historical data to support this claim should be viewed through a very skeptical prism and be tested as thoroughly as possible before being put into widespread use.

The focus of this article will be the realm of removal and replacement. While roof replacement design is worthy of an entire article in itself, by way of example, a sustainable replacement roof system might include the following parameters and design elements:

- Remove the existing roof system and install a vapor retarder/temporary roof. Often, this requires a gypsum-based coverboard with a base sheet and a smooth-surfaced, modified-bitumen capsheet or an EPDM membrane.
- Install a 1-1/2-in base layer of polyisocyanurate insulation.
- Place tapered 1/4-in/foot polyisocyanurate over polyiso.
- For mechanically fastened and fully adhered systems, add coverboard.
- Install 60- or 90-mil EPDM membrane.

Photo 1 – Long-term design solutions to roofing concerns often involve the work of associated trades. This mechanical penthouse requires complete tuckpointing and masonry restoration work prior to the commencement of roof replacement operations. (Photo by Tom Hutchinson.)

Photo 2 (above) – Energy conservation is a global crisis, so sustainable roof replacement should include the installation of substantial thermal insulation. Doing so often involves the raising of the perimeters. This photo shows one option preferred by the author in which vertical 2 x 12s are supported by steel angles and offset to provide a slope for the 2 x 4 cap. Note, too, that the wood blocking joints are not butted, but mitered at 45 degrees and screw-fastened. This prevents misalignment where wearing may occur. Photo by Tom Hutchinson.

Photo 3 – Dense coverboard protection over low-density insulation is recommended by the author below both fully adhered and mechanically attached membranes in order to promote long-term protection to both the insulation and roof cover. Photo by Tom Hutchinson.

- Raise roof curbs and plumbing vents.
- Relocate roof drains to achieve a more economical, tapered insulation layout and a more efficient drainage system.
- Raise roof edges to accommodate the installation of significant amounts of thermal insulation.
- Raise any mechanical equipment (HVAC, condenser units, pipes) as required.
- Design appropriate pipe curbs.
- Design details for complex conditions.

While there are certainly a number of options to consider while compiling a list of materials and design options, focusing on long-term performance should be given priority, whenever possible, over initial costs. Life-cycle analyses that have been conducted validate the value of focusing on long-term performance.[1] These reports support the proposition advanced by many roofing consultants that the investment in enhanced system design can produce relevant economic return to the building owner.

As an example, in a report issued by Jim Hoff using the Equivalent Uniform Annual Cost (EUAC) calculations,[1] 20-year roofing systems in the study offered long-term costs 10 percent to 15 percent lower than their 15-year counterparts. In addition, the EUAC of the single 30-year system studied offers an additional cost savings of 12 percent beyond a similar 20-year system.

A critical component in achieving sustainable roof systems is comprehensive construction drawings that appropriately communicate to the bidding contractors both the design intent and the scope of work. Simply put, specifications are not enough;

Photo 4 (left) – Note how the EPDM membrane at this drain drops into and above the clamping ring. Small details such as this communicate clearly to the owner and contractor that the designer cares about quality workmanship. (Photo by Tom Hutchinson.)

Photo 5 – This three-year-old, 90-mil EPDM roof, designed to FM 1-120 standards, is well on its way to achieving long-term service life (a minimum of 30 years). (Photo by Tom Hutchinson.)

the roofing system should be designed and drawn.

No amount of text can properly describe the detailing required in complex situations. Even simple details can become confusing when not properly drawn. Manufacturers' standard details and requests to have contractors basically design the roof with shop drawings are inappropriate for achieving long-term performance. Comprehensive drawings add greater clarity in understanding the project, eliminating many doubts and points of confusion that can lead to mistakes and, in some cases, legal action.

Effective communication has become more important in the past few years, if only because it has become more challenging. Much of today's workforce consists of people for whom English is not a first language or even a language they speak at all. Visual information usually overcomes any language barrier.

Photo 6 – This shows drainage areas on the roof in Photo 5. Courtesy of Tom Hutchinson.

Prior to releasing the contract document for bidding, this author recommends prequalification of contractors to confirm their suitability and qualifications for the particular project. Do not post the project with organizations that list projects for bid. Be selective and eliminate the unqualified early in the process. A poorly qualified contractor can lead to less than desirable results.

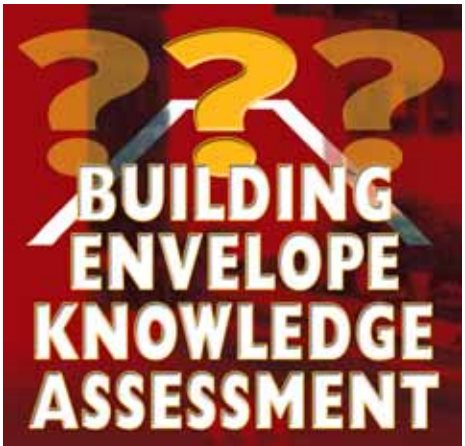
Construction Administration

Following the bidding, the emphasis shifts to construction administration and observation. The building owner (or more often, a roofing consultant hired by the owner) will need to diligently review the work being done to ensure installation complies with the bid set documents and fulfills the terms of the contract. An important part of contract administration is answering questions and arriving at decisions when dealing with situations that were unforeseen at the start of the project. These may include conditions found during the roof removal, such as deteriorated decking, buried conduit, and construction that differs from that which was assumed. Additionally, weather issues need to be considered. Installing roofing in inappropriate weather cannot be tolerated. If observed or discovered, such work should be rejected. We all have horror stories of a project kept "on schedule" by working through bad weather. The ultimate punishment comes when the roofing system fails to perform as expected because of this push to meet a deadline.

Maintenance

Certainly there are now general industry standards to follow when it comes to maintenance. In fact, most warranties require regular performance of maintenance. However, even the specter of keeping a warranty viable doesn't encourage every building owner to stick to the maintenance plan. In

Photo 7 – Another view of the same roof in Photos 5 and 6. Photo by Tom Hutchinson.



Test your knowledge of roofing systems with the following questions developed by Donald E. Bush Sr., RRC, FRCI, PE, chairman of RCI's RRC Examination Development Subcommittee.

1. **What have been the most common plaza waterproofing products?**
2. **What are natural clay types?**
3. **What are the most common loose-laid sheet systems?**
4. **What are the most common fully adhered systems?**
5. **What have been the most common pre-heated, liquid-applied systems?**
6. **What have been the most common cold-applied systems?**

Answers on page 20

BUILDING ENVELOPE KNOWLEDGE ASSESSMENT

Answers to questions from page 19:

1. • **Natural clay types**
   • **Loose-laid sheet systems**
   • **Fully adhered sheet systems**
   • **Preheated, liquid-applied systems**
   • **Cold-liquid-applied systems**
2. • **Spray Bentonite (1-part and 2-part)**
   • **Bentonite mats**
   • **Bentonite composite sheets (Bentonite adhered to HDPE)**
   • **Bentonite panels (Bentonite contained in cardboard)**
3. • **Thermoplastics (PVC, CPE, HDPE, polyolefin, and Hypalon)**
   • **Vulcanized rubbers (EPDM, butyl, and Neoprene)**
4. • **Thermoplastics (PVC, CPE, HDPE, polyolefin, and Hypalon)**
   • **Vulcanized rubbers (EPDM, butyl, and Neoprene)**
   • **Rubberized asphalt with polyethylene cover (peel-and-stick)**
   • **Impregnated asphalt composites**
   • **Thermoplastic asphalt composites**
5. • **Hot, rubberized asphalt (reinforced and non-reinforced)**
   • **Hot-mopped asphalt/coal tar (built-up)**
6. • **Cold, rubberized asphalt**
   • **Cold, polyurethane-based**

Reference: **RCI Educational Program - Waterproofing**

fact, most would not want to answer the question, "Do you spend as much time maintaining the roof as you do on your other investments?"

This author believes the industry standard of a twice-a-year maintenance program is not good enough. While inspection and maintenance in both spring and late fall are good, additional inspections are required, such as after violent storms and during the fall in areas of leaf loss. It should be remembered that powerful microbursts can even drive twigs into a roof, and that water builds up on a roof when leafs clog the drains. This can cause real concerns because of the extra load on the roof. In the fall, weekly cleaning of roof drains is required for roofs with overhanging trees. Additional inspections are also required following all HVAC maintenance work.

Visual observation is mandatory; the roof consultant or the owner or both should walk around the roof and pay careful attention. Has a fastener backed out? Did the insulation attached to asphalt or foam buckle up?

Make sure to watch roof curbs in particular, as they involve a great deal of hand work. The units above are often worked on, and crews such as window washers often tie off to them.

In addition to monitoring the roof, track those who access it. Track activity on the roof by workers sent up to conduct repair or maintenance of HVAC and other equipment. Accidents may happen and won't be reported. To avoid this, require all parties to notify the appropriate individual when they access the roof and inform them that the roof will be inspected following their visit. This commonly increases the level of responsibility of all parties accessing the roof.

This may seem ridiculously obvious, but fix problems right away. Contact the appropriate manufacturers in writing as soon as possible so they can document the report and contact a roofing contractor to make the appropriate repairs if warranted, or be held responsible if the repairs don't occur. If the particular item is not covered by the warranty, be sure the owner realizes that the responsibility for payment falls on himself or herself.

Conclusion

The increased focus on "green" construction should assist consultants in their efforts to promote sustainability and roof systems that live up to Gro Harlem Brundtland's words cited at the beginning of this article: meeting "the needs of the present without compromising the ability of future generations to meet their own needs." Still, consultants may face a challenge when translating these goals to a finished product on a rooftop.

One thing to consider in that situation: While consultants are meant to look out for the interests of the client, they can still be part of a team. In fact, our role is to lead that team in its effort to achieve an excellent result that will stand the test of time and meet the standards of sustainability. Through foresight, communication skills, respect for due diligence, patience, and consistency, positive results will be achieved.

References

1. "Equivalent Uniform Annual Cost: A New Approach to Roof Life Cycle Analysis," by James Hoff, Presentation to the 21st RCI International Convention, Phoenix, Arizona; published in *Interface*, January 2007.

Tom Hutchinson, AIA, FRCI, RRC

Tom Hutchinson is a graduate of the University of Illinois with master's degrees in both architecture and civil engineering. He is a licensed architect and a registered roof consultant. He has made numerous presentations on four continents. Hutchinson is a principal in Hutchinson Design Group, Ltd., Barrington, Illinois; Building Envelope Committee chair and former president of RCI, Inc.; current technical consultant for ERA (EPDM Roofing Association); Certified Energy Professional in the City of Chicago, and secretary of the CIB/RILEM International Joint Committee on "Roof Materials and Systems." He is a member of AIA, CSI, RCI, NRCA, ASTM Committee D-08 on Roofing, Waterproofing and Bituminous Materials, past president of the Barrington Rotary, and a past region director of RCI.