SAND2007-2516C

Roof, the Four-Letter Word That Ends in “F”
(How we went from mean to lean to green and beyond)

Presented at MARCON by

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May 9, 2007

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A Roofing Overview of Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND -2005-6648P

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Our Business: National Security

- **Core Purpose**: to help our nation secure a peaceful and free world through technology.
- **Highest Goal:** to become the laboratory that the United States turns to first for technology solutions to the most challenging problems that threaten peace and freedom for our nation and the globe.

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Mission-Driven Laboratory

SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/ SNL Roofing Program/SNL Roofing Program

We serve many agencies of the US Government with:

- Design and development: nonnuclear portions of US nuclear weapons
- Production: advanced components
- Safety, security, use control
- Treaty verification, nonproliferation, counterproliferation
- Advanced military technologies
- Energy and environment
- Homeland security, countering weapons of mass destruction

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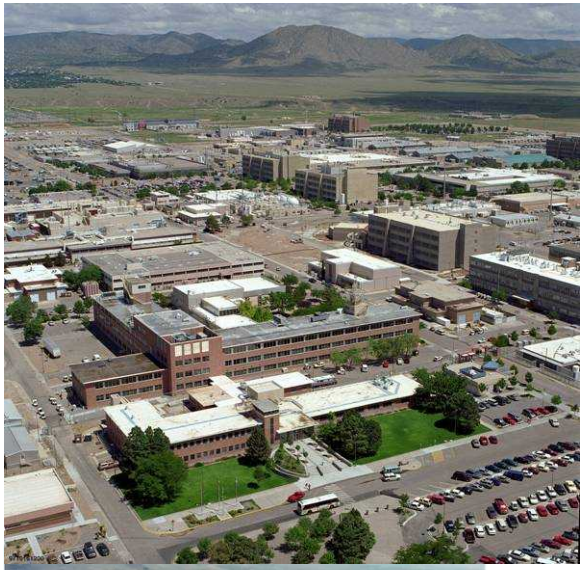
Distributed Facilities to Meet National Needs



Albuquerque,
New Mexico

Kauai Test Facility,
Hawaii

Tonopah Test Range,
Nevada

Yucca Mountain,
Nevada

WIPP, New Mexico

Pantex, Texas

Livermore, California

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Four Mission Areas

- Nuclear Weapons
- Defense Systems and Assessments
- Energy, Resources, and Nonproliferation
- Homeland Security and Defense

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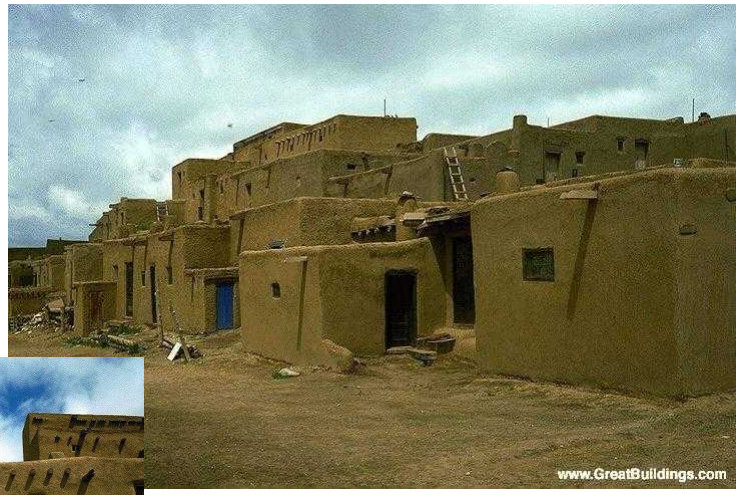
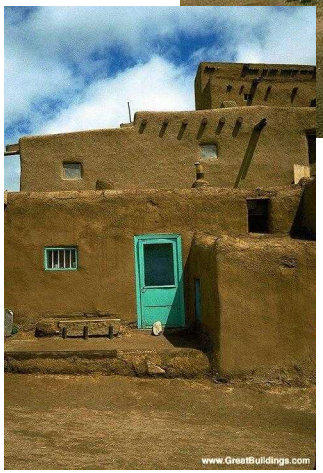
The History of Roofing

- **Since the earliest times, humans have attempted to create roof coverings which would shield them from the elements.**
- **Material provides protection from the elements and were sustainable products:**
  - **-Highly reflective**
  - **-Thermal properties.**





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SNL-Roofing History

- In 1994, Sandia National Laboratories roofing program was 100% reactive.
- After a typical rain an average of 115 leaks were reported.
- Multitude of roofing systems to maintain (bitumen, modified bitumen, built-up, single-ply, PVC, shingle, metal).
- Over 25% of our roofs were considered to be in the failed state.

Current Condition

- **Since the program was established, the average number of roof leaks after measurable precipitation has dropped by a factor of four.**
- **The Program quantifies the condition of these roofing systems, focuses repair activities, and projects the schedule for re-roofing activities.**
- **Manage more than 3 million SF of roofing on approximately 175 buildings.**
- **Average fewer than 5 roof leaks per rain event and the staff consists of one Architect, one Roofing Specialist and a part-time crew of 2 – 4 Contract Roofers.**

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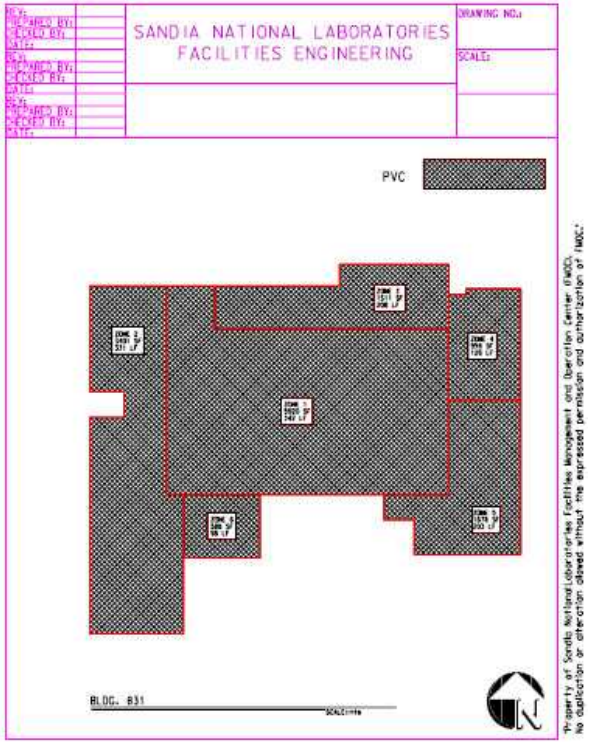
Current Process

- Roofing maintenance is no longer reactive, but has taken on a preventive approach to roofing.
- A graded approach is taken in assessing the buildings. Higher maintenance buildings are looked at bi-annually; buildings of "lower maintenance" are inspected annually or three year interval. MO's are not inspected.



- The roof of each building broken down into roof zones. Each roof zone is given a roofing condition index (RCI) from zero to 100. Zero being a roof in a failed condition and 100 being a roof in excellent condition.
- The assessment of each roof zone provides a list of deficiencies. The type of deficiency, the quantity, and the severity (hi, med, low) are all identified. If a deficiency is identified, a repair work order is generated. In many cases completing the repairs increases the RCI significantly.

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The Journey of Materials and Engineering

- 60-mil single-ply TPO membrane
- Cost effective to install
- Installs cleanly
- Ease of condition assessment
- Repairs/modification are done very easily

- Hot-air welding is required on all projects
- Roof life expectation of

  20 + years

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Roles and Responsibilities

- **Systems Architect/Roofing Program Manager**

  -Review the results of condition assessments and approve any resultant actions.

  -Establish the condition assessment priorities and frequencies.

  -Develop and update roofing specifications and standard drawings.

- **Roofing Technologist**

  -Perform roofing condition assessments based on the PM schedule

  -Oversee roofing repairs by the Service Contractor.

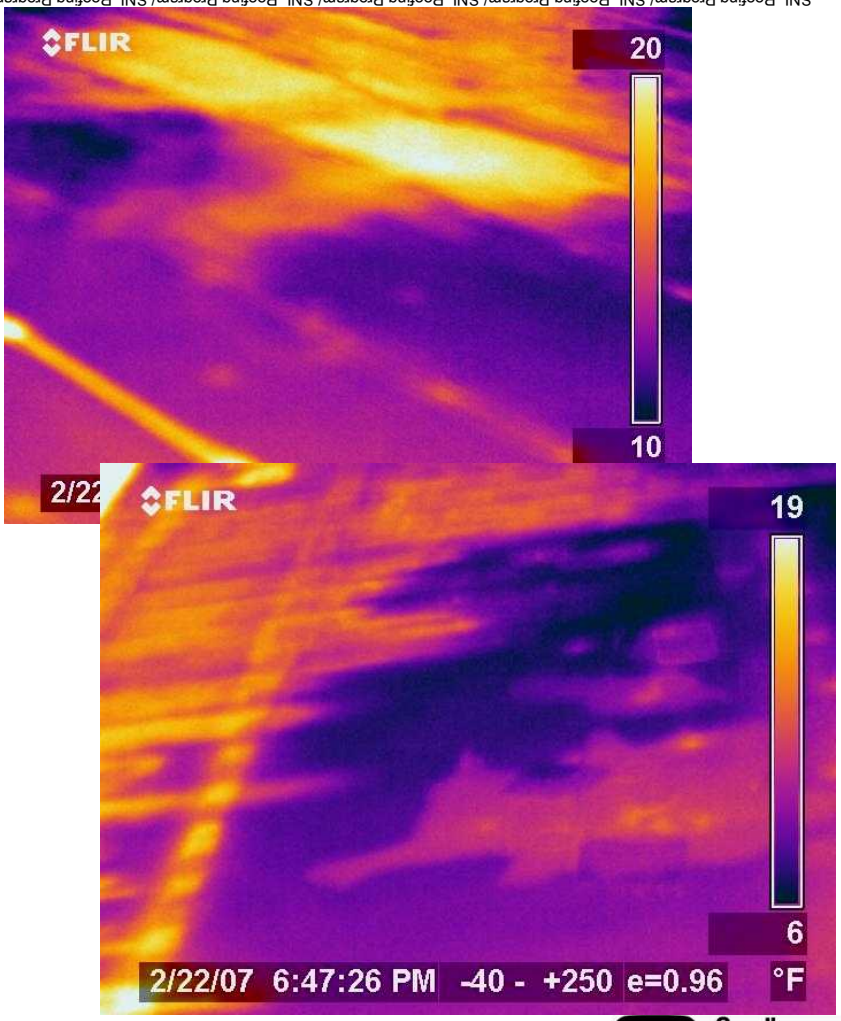
  -Input the results of inspections and repairs, if any, in the Roofer Program

- **Roofing Service Contractor**

  -Perform repairs to building roofs based on deficiencies identified during roofing inspections

Roofing Inspection Process

- SNL has developed a graded approach for assessing buildings. Assessment evaluations allow for long term assessments, re-roofing and preventative maintenance planning.
- Roofing is proactive not reactive.
- Thermography has become a more integral aspect in the inspection process. The useful, non-intrusive technique for quantifying the condition of roofs by indicating the entrained moisture under the roof membrane provides a great deal of information.



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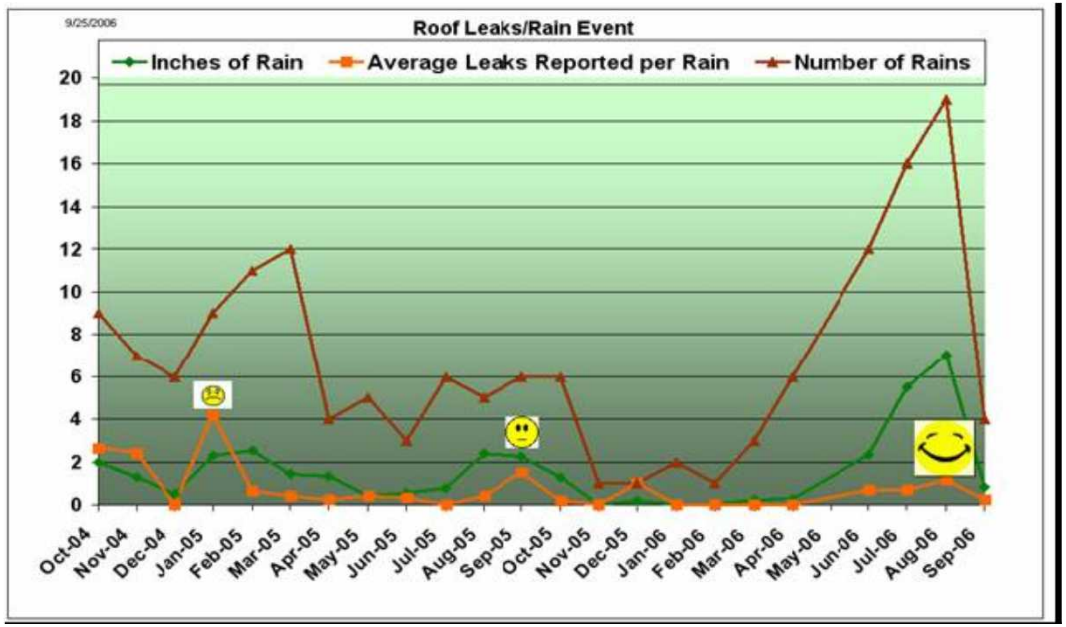
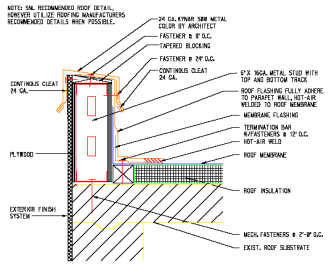
Roof Trending



- **The SNL/NM Roofing Team provides a high quality roofing infrastructure to all building occupants at SNL/NM.**
- **A key measure of success is the number of reported roof leaks during and following a rainy period.**
- **SNL was one of the DOE complexes which had an external evaluation completed.**

- **Upon completion of the evaluation, SNL/NM received exceptional results evident from the evaluations "The state of Sandia roofs and management of roofs is excellent".**

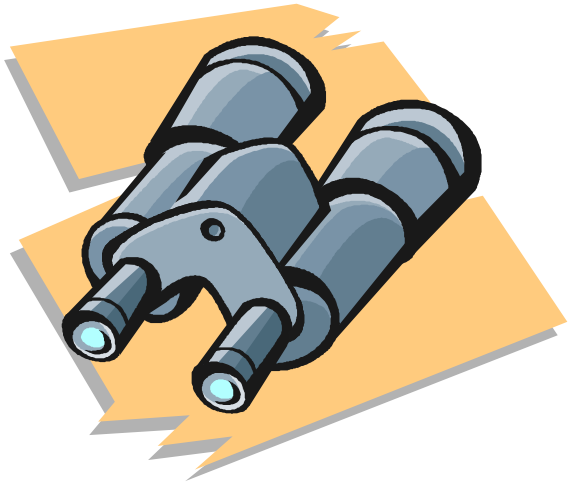


Roofing Program Process

- **Annually the Roofing Team reviews/updates DOE mandated, OSHA, ES&H, Safety and SNL checklist documents.**
- **Actively advertise the roofing program, this is accomplished through the SNL News and other News articles.**
- **Monthly meetings with SNL Maintenance, Site Planning, Facility Building Managers, Construction Inspectors and various other Line organizations to incorporate any concerns/issues which have presented themselves.**

Safety

- 12,000 inspectors on site everyday
- Odors
- Unwarranted concerns



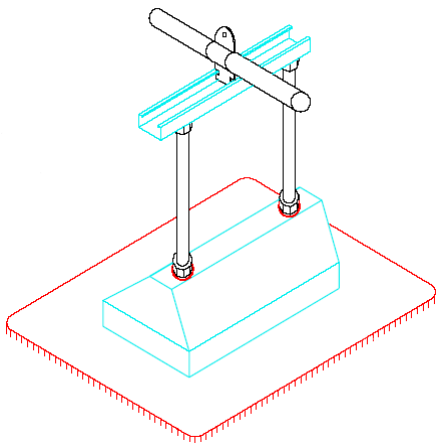
Roofing Software

Currently, Sandia utilizes a roofing management system for documenting and planning all roofs. Information provided includes:

- **Portable data collection devices**
- **GIS Site maps**
- **Asset Management**
  - **Collect inventory data (quick reference for roof conditions)**
  - **Inspection schedules and work plans**
  - **Planning tool for budgeting**
  - **Thermography**
  - **Life cycle, etc...**
  - **RS Means costing loaded internally**

Roofing Specifications/Drawings

- A formal relationship with Lightning Protection has been established for interactions with roofing projects.High $$ if missed.
- Five (5) detailed standard specifications.
- Detailed Roofing drawings.
- 1000S Specification for many of our office buildings has TPO single-ply roofing specified .



- Roofing submittals and drawings for new and re-roofing construction projects are archived in a document management system (Web-file share).
- As built information provides understanding of the materials and roofing layout.
- We then utilize the Roofing program to maintain life-cycle costs and preventative maintenance.

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Discipline Coordination
Building 894

- When the roof was inspected by the SNL Roof Inspector and Contractor, numerous repairs were made because of debris that had been left on the roof of the facility. A major item of concern was a sheet of metal which created numerous “gashes” into the existing roof membrane.
- There have been numerous instances, observed by the Roofing Team which resulted in similar damage to SNL’s roofs. Future caution should be taken for ensuring that all surplus material is removed from the roof. This is also part of the mindset for safety and maintaining good housekeeping for SNL.

Sustainable Principles

One of the primary objectives of the SNL/NM Roofing Team Program is to incorporate environmental sustainability features into the roofing system.

- **Reflective roofing can reduce the peak cooling demand of the building by 10-15%.**

Material Type	Bright White Material	Rough White Surface	Light Color	Intense light color (green, red)	Medium Gray	Built-up with gravel	Asphalt Shingle	Black Material
Roof Temp. (F)	15F	35F	15-55F	79-83F	52F	50-65F	72-90F	90F

Sustainable Principles

- **Roof Life Extension: Bio-based coatings are utilized (containing low VOC) preserve and extend the life of the roofs by 15 years.**
- **Reuse and Recycling**

  -A new TPO roof can be 100% recycled if replacement is necessary.

  -Gravel is given to maintenance to be used as landscaping gravel and erosion control. Total: 219 tons of recycled gravel.
- **Enhancing the energy efficiency, R-30 insulation.**

Sustainable Principles

Maximized principles to all aspects of Roofing:

- Meet California South Coast Air Quality Management District, Rule 1168, Adhesive and Sealant Applications and Regulation 8, Rule 51, Organic Compounds.
- All contractors are required to submit manufacturer's documentation of Energy Star.
- All contractors are required to submit Material Safety Data Sheets (MSDS) and documentation of Volatile Organic Compound (VOC) content.
- Documentation of recycled content (minimum 9 %) for polyisocyanurate insulation and each project must meet an average R-value of 30.

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Building Integrated Photovoltaics

The SNL/NM Roofing Program is pro-active, efficient, and demonstrates leadership. Building 833 was a recently re-roofed with a new thermal propylene olefin (TPO) membrane which has embedded photovoltaic (PV)

- **PV roof is the first of its kind at Sandia**
- **Offsets some of the commercial electric power**
- **Higher insulation values (R-30), meeting the requirements for Energy Star**
- **3.0 kW of power for the building**

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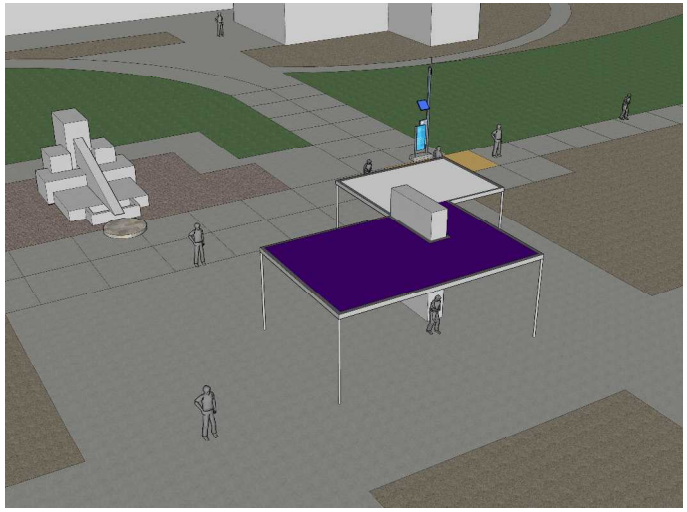
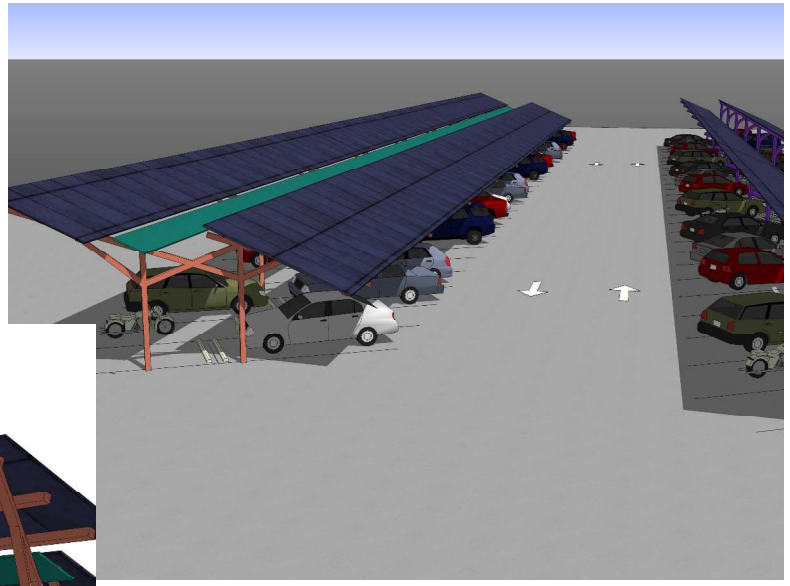
The Future of Sustainable Roofing



Roof mounted 3.0 kW Photovoltaic Shade Structure



Roof mounted 1.0 mW Photovoltaic Shade Structure

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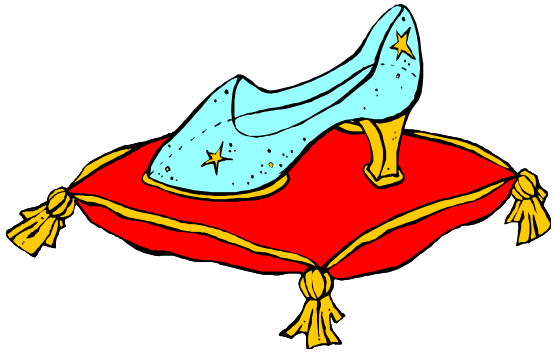
Awards

- NNSA 2006 Pollution Prevention Awards Program:
- Environmental Stewardship Award
- SNL EMS Excellence for Policy and Procedures
- Certificate of Appreciation for exceptional customer service in warranty process with faulty PV membranes
- ERA Nomination for the Roofing Team
- PQA Nomination for the Roofing Team

Conclusions



- **Cinderella money: Advantage of FY funding to pre-purchase material for later installation.**

- **Utilization of pre-designed project and utilized FY funding streams.**
- **Continued pursuit of improved inspections and implementation of BIPV.**

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