



RELIABILITY FIRST

ANNUAL REPORT

2021



Letter from the Board Chair Simon Whitelocke

Although 2021 presented its share of challenges with the continuing pandemic and increased cyber security threats, RF continued forward with its work to identify, communicate, and mitigate risks across the Region.

This work is essential, and this Annual Report provides an overview of major RF initiatives from the past year to reduce risk in key areas. These include creating new tools to enhance cyber resilience and preparedness, and cross functional efforts to reduce misoperations and facility ratings issues within the RF footprint.

RF and the whole ERO Enterprise worked together to address the 2021 cold weather event and further strengthen the grid against extreme weather, and this is discussed as well. This report also includes useful compliance trends and takeaways.

There is also a letter from RF's Chief Security Officer Marcus Noel on the importance of remaining vigilant for cyber threats, which only continue to increase. I echo his message and encourage everyone to continually push to improve your cyber defenses to meet the constantly evolving cyber threats.

I would like to welcome our new Board members: Joanna Burkey, Chief Information Security Officer for HP; Courtney Geduldig, Corporate Vice President for Public Affairs for

Micron Technology; Ken Seiler, Vice President of Planning for PJM Interconnection; and Nelson Peeler, Senior Vice president of Transmission and Fuels Strategy and Policy for Duke Energy. Courtney and Joanna are Independent Directors for RF, Ken represents the RTO Sector, and Nelson represents the Transmission Sector. Additionally, Rachel Snead was reelected to continue representing the Supplier Sector, and Bob Mattiuz was reelected to represent the Transmission Sector.

We will miss departing Board members Larry Irving, Lynnae Wilson, and Jennifer Curran, and we are grateful for their service. I'm also pleased to note that Larry Irving has joined the NERC Board of Trustees, where his exemplary leadership and commitment to the ERO's mission continues in that role.

On behalf of the entire Board of Directors, thank you to all of those who worked with RF and the greater ERO Enterprise to advance reliability this year. I look forward to our continued collaboration and forward progress in 2022.

Forward Together,
Simon



Letter from the President & CEO Tim Gallagher

2021 marked RF's 15-year anniversary, and I encourage you to read our special 15th anniversary newsletter in tandem with this Annual Report. It contains reflections on RF and its history, and thoughts on the next 15 years.

A 15 year anniversary is a good moment to pause and reflect, and celebrate how far we've come. NERC and the Regions have truly come together in recent years as one unified ERO Enterprise, and we've built fruitful relationships with our entities and stakeholders that have resulted in real improvements to the reliability, resilience, and security of the grid.

As Simon notes in his letter, RF embarked on a number of cross functional initiatives this past year to address key risks, and you will read about these within this report. I'm proud of the team for their hard work on these initiatives, and for all their work over the past year.

In 2021, we welcomed new teammates and Board members. I was happy to welcome Beth Dowdell this year as our new Sr. Director of Corporate Services, and Marcus Noel as our new Chief Security Officer.

I'm proud to have our new Board members, Joanna Burkey, Courtney Geduldig, Ken Seiler, and Nelson Peeler, as part of the RF team. They all have impressive credentials and have already provided great value to our organization.

Larry Irving, Lynnae Wilson, and Jennifer Curran left the Board this year, and I would like to thank them for their invaluable contributions to RF.

I would also like to recognize the retirement of Larry Bugh, who served as RF's Chief Security Officer, and Ray Sefchik, who served as RF's Director of Entity Engagement. Larry and Ray were integral members of the team that built RF into the successful organization it is today, and we wish them both the best in their retirement.

Finally, a big thank you to everyone at RF and in the industry for their hard work in 2021 to address and mitigate threats, and keep the lights on. While we continue to face challenges related to the pandemic, as well as increased cyber threats related to geopolitical issues, I am confident in our ability to work together to address these challenges and emerge even stronger than before.

I look forward to working with you all this year in 2022, and applying what we all learned in 2021 to our efforts going forward to ensure the reliability, security, and resiliency of our grid.

Forward together,

Tim



Our Essential Purpose:

To serve the public good by protecting, improving, and ensuring the availability of electricity for all, sustain health and safety, safeguard the economy, and preserve our way of life.

Our Mission:

To identify, prioritize, and assure effective and efficient mitigation of risks to the reliability and security of the North American bulk power system.

Innovation Awards

RF's fourth annual Innovation Awards took place in December 2021. The event encourages staff to try new ideas and projects and recognizes exceptional work that took place over the past year.

During the event, we discussed the "why" behind our innovation efforts, and how it ties back to our mission of preserving and enhancing the reliability, resilience, and security of the Bulk Power System. Attendees discussed the importance of innovation, noting that new and complex risks require new and thoughtful solutions, and innovation helps efforts to anticipate and assess emerging

risks and discover the unknowns.

RF gave two awards: one for best innovation project and one for best continuous improvement project. Patrick O'Connor, Senior Counsel, and Johnny Gest, Manager Engineering & System Performance, won the Innovation Award for the Design Structure Matrix (DSM) Risk Rankings project. Denise Hunter, Principal Technical Auditor (now Director of Corporate Risk Management at NERC), Zack Brinkman, Manager of CIP Compliance Monitoring, and Megan Baucio, Communications Manager, won the Continuous Improvement Award for their work on the

Internal Controls Workshop. These award-winning efforts are described further below.

RF also presented an Innovation Appreciation Award to Carl Dister for his years of work and outstanding leadership on RF's innovation projects, and to David Sopata for his work on the [ERO Security Integration and Technology Enablement Subcommittee \(SITES\) team](#). The SITES team identifies, assesses, and recommends ways to incorporate cyber and physical security best practices and emerging technologies in a secure manner.



Best Innovation:

The DSM Risk Rankings team published "A Network Approach for Assessing Risks to the Electric Grid." This paper changed the landscape of risk identification and quantification at RF. Using a DSM to model relationships, industry experts assessed the possibility of causal relationships between risks to the BPS. This networked approach to risk provided a more comprehensive understanding of risk relationships, including opportunities for reprioritizing risk mitigation.

Best Continuous Improvement:

The Internal Controls workshop gathered industry experts in misoperations and systems security management to learn about and build internal controls to enhance their existing processes. Starting with process flow charts, attendees identified opportunities for adding new internal controls, and then worked to name, document, describe, and assess them.



Resilience Efforts and Innovations

As the risk landscape continues to evolve, operational and cyber resilience remains a major area of focus for RF. Resilience measures help anticipate and prevent critical threats, and detect, absorb, and recover from them when they do occur.

In 2021, one of the most frequently discussed risks was cyber supply chain attacks, such as the massive and widely publicized SolarWinds compromise. Along with our compliance efforts (CIP-013) to mitigate this risk, RF jointly published a [peer-reviewed paper on supply chain resilience](#), which was presented at the 2021 international IEEE Blockchain conference. The paper proposes a BES blockchain-based Cyber Supply Chain platform for Energy Delivery Systems, that can provide a cyber risk management capability to defend and respond to these attacks.

At GridSecCon 2021, RF introduced the Incident Response Performance Assessment Tool (IRPAT), to add to RF's existing Cyber Resilience Assessment Tool (CRAT) and Insider Threat Preparedness Maturity Assessment Tool (InTP). The launch of the IRPAT was a success, with over 100 registrations and considerable interest from the E-ISAC and industry. The IRPAT is a GridEx-style on-demand tool with table-top exercises for entities to practice and enhance their ability to detect and respond to emergencies. RF's IRPAT, CRAT, and InTP tools are voluntary, outside of the compliance space, and include discussions with RF staff on the results to help enhance entity capabilities. Additional information on these tools are available on our [website](#), and interested entities can contact [Bheshh Krishnappa](#).

In June, RF hosted our first [Operational Resilience Webinar](#). With guest speakers from NERC, EEI, ESCC, the NAGF, the Argonne National Laboratory, IEEE, PJM, ITC, MISO, FirstEnergy, and PPL, this event brought together industry experts to discuss extreme weather, system design and human performance, resilience during the pandemic, and communication during emergency operations. This is just one example of many events across the ERO focusing on resilience topics.

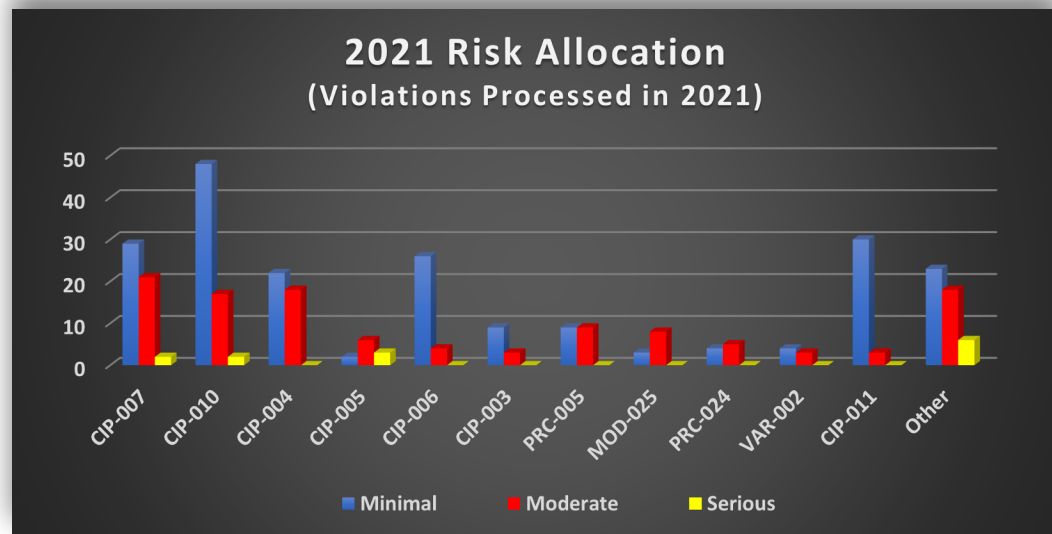
Another key aspect of resilience is mitigation of the risk of insider threats. Along with the InTP tool mentioned above, RF built upon the success of the [2020 Insider Threats Webinar](#), collaborating with SERC on their event, "[The Scoop on Insider Threat](#)." RF encourages entities to incorporate Insider Threat mitigation strategies into existing security programs, and to share lessons learned and experiences with the industry through CIPC, E-ISAC and other channels.

2021 Noncompliance Trends and Takeaways

RF tracks various metrics to identify noncompliance trends and shares these metrics throughout the year during Board meetings, workshops, and webinars. Consistent with the wider ERO Enterprise, RF has experienced a high volume of CIP noncompliance since CIP version 5 went into effect in 2016. Page 8 of this report includes a letter from our CSO, Marcus Noel, on the need for all of us across the industry to stay vigilant on cyber security, given the seriousness of the threats in this area.

The percentage of noncompliance identified through self-reports and self-logs in 2021 was slightly higher than previous years, with entities self-reporting and self-logging 95% of noncompliance. This is a positive trend showing strong detective controls at entities, and also relates to the increased numbers of self-logs (which are presumed to be minimal risk). In other words, while the volume of violation intake remains high, the overwhelming majority are self-identified and many are presumed to be minimal risk.

However, RF also processed a number of higher risk violations in 2021, showing the need for entities to remain vigilant in focusing on sustainable programs and continuous improvement. The chart above shows the most violated standards in the RF footprint that were processed in 2021.



A. CIP Trends and Takeaways

The majority (78%) of noncompliance identified in 2021 were CIP issues. RF identified CIP-005-5 (Electronic Security Perimeter(s)), CIP-007-6 (patch management), and CIP-010-2 (change management) as the highest risk areas based on violations processed in 2021. We encourage entities to examine their internal controls, processes, and mitigation in these areas.

The most frequently violated CIP standards in 2021 were CIP-004-6 (access management) and CIP-010-2 (change management). These standards govern high-frequency conduct with strict time requirements, so we expect that these standards will usually be among the most frequently violated standards. While most of these issues tend to be low risk and can be an indication of an entity's good detective controls, some entities have experienced higher risk issues in these areas given the scope and the duration of some of the issues identified.

B. Operations and Planning Trends and Takeaways

While less than a quarter of the violations identified in 2021 involved Operations and Planning Standards, violations of these standards made up a large portion of the higher risk violations processed in 2021. These higher risk violations related to facility ratings and vegetation management issues.

Facility Ratings and vegetation management have been areas of focus for the ERO Enterprise for the past several years, and Page 9 of this report describes cross functional efforts to help address these risks. While we believe entities are continuing to improve in these areas based on individual engagements and outreach efforts, we urge entities to remain vigilant in these areas.

The most frequently violated Operations and Planning Standards in 2021 were PRC-005-6 (Protection System maintenance and testing) and VAR-002-4.1 (maintaining generator voltage). Similar to the top violated CIP standards, these standards govern high-frequency conduct, so we expect more issues in these areas compared to others. However, some entities have also experienced higher risk violations for these high-frequency Standards, and we recommend keeping a close eye on controls in these areas.



Letter from the CSO

Marcus Noel

2021 was quite a year. Natural disasters disrupted the supply chain, swiftly made pandemic adaptations have altered security protocols, and critical infrastructure has become an increasingly popular target for state and non-state actors alike.

The adversary has been busy with disruptive ransomware attacks like Colonial Pipeline, exploits of pervasive vulnerabilities like log4j, and a never-ending barrage of compromises against our trusted vendors. The attacks are increasing, executing faster, and finding and retaining cyber security talent has become increasingly difficult.

Our sector is an especially lucrative target for state-sponsored attacks. As we enhance our capabilities and implement the latest security technologies, we have to make sure that we remember the basics:

- Know what's in your environment and know what it's running.
- Patch, assess, and re-assess vulnerabilities and misconfigurations.
- Perimeters are disappearing so add layers. Push controls down to endpoints where possible.
- Disable unnecessary accounts, enforce password policies, and implement MFA where you can.
- Log what you can, alert on what's important, monitor those alerts.
- Educate, test, and educate some more.

What we do is important. What we're protecting is important - to our companies, to our families, and to our nation. Keep up the good fight.

Forward together,

Marcus

Facility Ratings and Vegetation Management

Accurate facility ratings are key to the reliability of the Bulk Power System: system operators depend on them to control and operate the system, and they are utilized in the system planning process to determine the need and timing of system reinforcements. RF has been taking extra steps to ensure entities have accurate Facility Ratings in place since 2018, and in 2021 this effort continued.

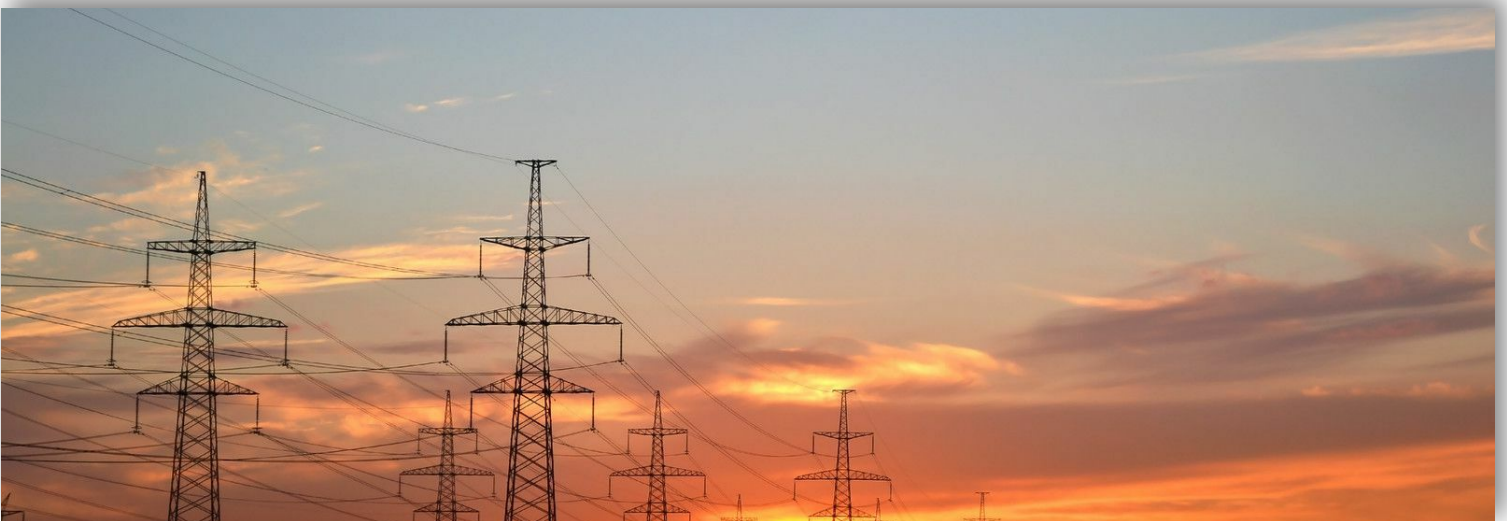
In conjunction with the rest of the ERO Enterprise, RF took several steps to help ensure accurate facility ratings:

- Our compliance monitoring team adjusted its oversight approach and added a field verification component.
- We participated in industry and ERO task forces to identify strategies and discuss methods to ensure accurate facility ratings.
- We created an internal dashboard to trend and track the issue across the RF footprint.
- We discussed facility ratings during RF , NPCC, and SERC outreach events.
- RF entities shared their best practices as well - for example, during our fall workshop, Duquesne shared a presentation on its FAC-008 program.

Vegetation management was another area of focus in 2021. Our data analysis and metrics indicated that vegetation issues were increasing on 100-199kV facilities. To address this risk, RF took a number of actions:

- We held one on one meetings with 15 different entities to discuss vegetation outage trends and challenges, as well as entity specific outage information and internal controls.
- Our compliance monitoring team began field site visits to check entity vegetation management programs.
- We focused on vegetation management practices during two different RF Tech talks in 2021.

These efforts will continue in 2022. RF is hosting a facility ratings webinar on April 4, 2022. RF also facilitates a vegetation management Community of Practice where entities can share best practices and learn from each other. Please contact [Thomas Teafatiller](#) if you are interested in joining.



Cold Weather Preparedness

In February 2021, an extreme cold weather event caused outages across Texas and the South Central United States. During the event, 1,045 BES generating units were affected, and more than 4.5 million people lost power.

In the months following, RF staff members participated in a team with FERC and NERC to conduct a joint inquiry examining the event, its causes, and creating recommendations to prevent future events from occurring.

This was a major undertaking throughout 2021, and the joint inquiry team released its final public report in November.

The report included 28 recommendations in various areas, from improvements to the Reliability Standards to enhanced gas-electric coordination and weather proofing mechanical and electrical components.

In addition to the extensive work on the cold weather inquiry and report, RF staff continued its annual efforts to conduct cold weather preparedness outreach.

For example, RF and SERC worked together to hold a joint Cold Weather Preparedness Webinar, and RF maintains a Cold Weather Preparedness page on our website's Knowledge Center, with resources and useful documents for entities to reference. RF and SERC are also working together to create an e-learning module on winter preparedness for release in 2022.

Additionally, since 2014, RF has conducted annual generating facility visits, and we continued this work in 2021. During these visits, our winter preparedness teams discuss winter preparedness challenges with the entity; identify and share best practices; review the entity's winterization plan implementation records; and conduct walk-throughs of areas of the facilities susceptible to extreme weather challenges. Our teams collect lessons learned, best practices, and positive observations during these visits, which we then share with entities.





Misoperations

Minimizing protection system misoperations is critical to reliability, as misoperations can aggravate the magnitude and scope of system events. Each year, the ERO calculates the protection system misoperations rate within each region, to determine the relative performance of protection system operations and identify concerning or improving trends around relay performance.

2021 marked the seventh consecutive year that the number of misoperations in the RF footprint decreased, and the first year that the rate was below 10%. These improvements reflect a concerted, multi-year effort to address this risk and decrease the amount of misoperations in our regional footprint.

In 2021, RF continued this effort with extensive analysis and outreach activities. RF staff analyzed MIDAS data and conducted visits with entities to discuss our analyses and any identified causal factors. RF also discussed misoperations at our Board meetings, monthly Technical Talk webinars, annual workshop, and in our quarterly newsletter.

During RF's Protection System Subcommittee meetings, human performance workshop, and protection system workshop, RF staff trained and led discussions with entity field personnel and relay engineers on misoperations causal factors and mitigation methods.

In addition to attending outreach events, entities collaborated with RF and each other to continuously improve their operations. Entities participated in a quarterly misoperations peer review process to evaluate the accuracy of MIDAS data and discuss best practices. Several entities also participated in RF voluntary appraisals and self-assessments to assist them as they progressed through program enhancements to decrease misoperations.

Finally, RF staff was proud to work on a joint review team with FERC and NERC to create the [Joint Review of Protection System Commissioning Programs report](#), after MIDAS data showed that up to a third of misoperations should have been detected through protection system commissioning (PSC) programs. The team assessed entity PSC programs, and identified numerous recommendations and best practices for PSC programs to help reduce misoperations.

Situational Awareness - Real Time Assessments and EMS Outages

The BPS operates in a continuously changing environment, and its data and information are constantly changing as well. System Operators must remain situationally aware to maintain system reliability, anticipate events, and respond appropriately when needed.

To maintain the reliability of the BPS, System Operations groups use various tools such as Energy Management Systems (EMS),¹ Real Time Contingency Analysis (RTCA) software that models the system, and load and weather forecasting tools.

RF works with NERC and the other Regional Entities to assess the availability of these tools, identify causal factors related to their unavailability, and educate industry through various outreach efforts including the development of Lessons learned, webinars and workshops.

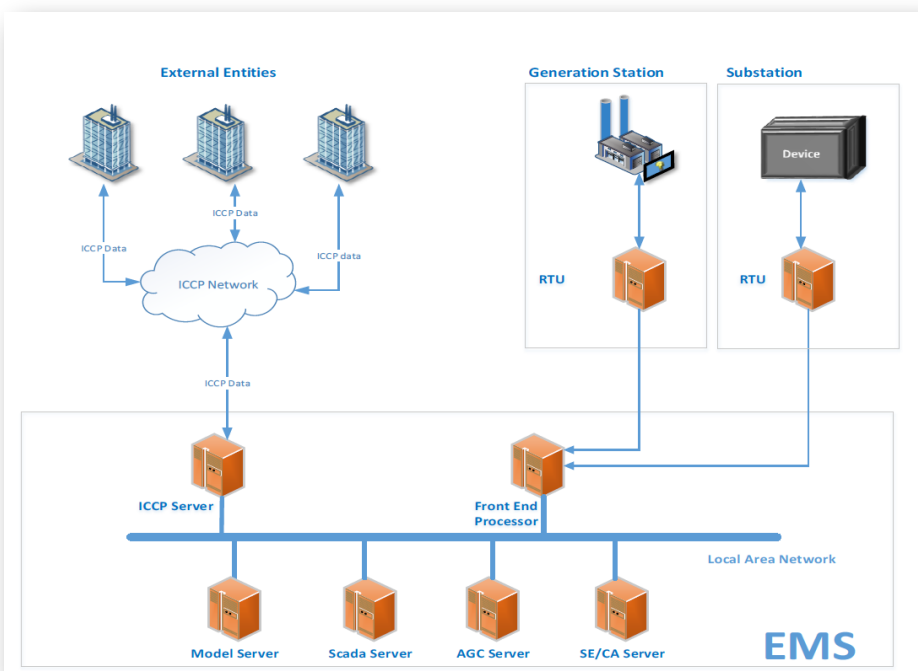
For example, RF recently teamed up with FERC, NERC and other Regional Entities to better understand the strategies and techniques Reliability Coordinators and Transmission Operators use to perform Real-time Assessments.²

The team conducted on-site discussions with nine participating Reliability Coordinators and Transmission Operators, focusing on Real-time Assessments during events where the participant experienced a

loss or degradation of Real-time data or primary tools used to perform Real-time Assessments. The team's work was not a compliance review of prior activities, but instead focused on current practices and procedures.

The goal of this effort was to better understand the strategies and techniques used by participants to perform Real-time Assessments. The entities that participated provided substantial feedback, and a joint report was issued in 2021 that outlined recommendations and best practices identified by the team.

Following the issuance of the report, RF conducted outreach to share these recommendations and best practices with our entities.



¹ An EMS is a computer-aided environment used by system operators to monitor the BPS. The EMS allows system operators to monitor and control all aspects of the grid, including frequency; the status of switching devices; and real and reactive power flows on generators, transformers, and transmission facilities; as well as the status of applicable EMS applications like the State Estimator, real-time contingency analysis (RTCA), automatic generator control (AGC), and/or alarm management.

² As a part of their duties, System Operators and their back-office support teams perform evaluations of system conditions called Real-time Assessments. These evaluations of system conditions use Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions.

Analytics and Dashboards

As part of the 2020 reorganization of RF, the Analytics department was created with the goal of centralizing the data we use into a data warehouse and using data to create visualizations to drive decision making, uncover unknown risks, and predict where problems may develop. To date, the Analytics department has created 10 visualizations with

additional visualizations in development. These visualizations are used cross departmentally to provide trending of key metrics across the organization. Below are examples of how RF's analytic capabilities are used in different areas of our organization:

Event Analysis

Event Analysis dashboards provide a quick visual display of Event Analysis Log data captured from 2014 through the present. This information provides enhanced visibility, efficiency, trending and forecasting ability. It also allows for better decision-making utilizing key performance indicators.

Compliance Monitoring

Compliance Monitoring dashboards provide a way to view our monitoring methods more efficiently. Having this additional visibility has complemented RF's risk-based decision making process for determining monitoring activities and outreach. Over 20 different visuals allow the Compliance Monitoring team to more easily track risks, standards, entities, and oversight activities.

Engineering & System Performance

Engineering & System Performance (ESP) dashboards summarize data and metrics derived from the Misoperation Information Data Analysis System ("MIDAS"), Generator Availability Data System ("GADS"), and Transmission Availability Data System ("TADS"). These systems are active repositories of outage and misoperation data, and the dashboards help identify risk areas and prioritize engagements and outreach with external stakeholders.



Outreach



Due to COVID-19, RF's outreach was once again virtual in 2021. However, this presented an opportunity to collaborate with industry experts across the country and reach new audiences. Technical Talk with RF (Tech Talk), our monthly open webinar and forum, averaged 270 attendees per event in 2021. During these events, we provided information about new standards, Align, and upcoming ERO events; and subject matter experts discussed various pertinent topics, including internal controls, virtualization, patching, distributed energy resources, facility ratings, and vegetation management.

RF chooses topics for Tech Talks based on feedback loops from our audits, self-reports, assist visits, and CMEP Implementation Plan risk elements. This ensures that we address emerging risks and areas where entities are seeking additional guidance.

It is important to us that technical papers, guidelines, and other white papers published by the ERO do not sit on the shelf – we regularly discuss these documents with our stakeholders regarding how to implement these best practices and controls.

With a focus on creating sustainable programs, RF's two-day Fall Workshop was a success, as we supplemented RF's subject matter experts with additional regional experts and guest presentations from Joanna Burkey, RF independent board member and CSO of HP, Mark Hoog from the Vector

Academy, and Niki Schaefer, our General Counsel.

Throughout 2021, RF offered a variety of targeted webinars. Our enforcement team hosted an event on themes and trends from self-reports, and mitigating actions and lessons learned from some of our most frequently violated standards.

In June, RF hosted an Operational Resilience webinar (discussed on page 6 of this report), and a Design Structure Matrix workshop (discussed on page 5 of this report). RF also hosted our annual Protection, Human Performance, and Internal Controls webinars; and participated in a joint SERC/RF Cold Weather Preparedness Webinar hosted by SERC.

We are also proud to collaborate with industry through our subcommittees, with the ERO committees and task forces, through our quarterly newsletter, and our Assist Visit program, appraisals, and innovative self-assessment tools that are available on-demand. Stay tuned to our monthly letter, social media, and our quarterly newsletter for updates on upcoming events!



State Outreach

RF engaged in significant state outreach in 2021, as part of an ERO Enterprise-wide initiative to increase communications and serve as an independent reliability expert for state public utility commissions and legislatures. This outreach provides an additional reliability-focused resource for the states as they too address the many changes and emerging risks facing the electric industry.

Throughout the year, we met with staff and commissioners from public utility commissions across the RF footprint to discuss reliability issues of importance to them and how RF can help provide information and education in these areas. We also shared ERO and RF reports, assessments, and outreach events with the public utility commissions, so their staff and commissioners can also benefit from the information and outreach we provide to our stakeholders.

In 2022, these efforts are expanding to include communications and presentations to state legislatures, including state senate and house energy committees. In January, Tim Gallagher and Jim Robb presented on national and regional reliability topics to the Indiana State Senate Utilities Committee. They discussed NERC's 2021 Long-Term Reliability Assessment and 2021-2022 Winter Reliability Assessment, as well as resource adequacy and winter reliability information specific to the RF region and the state of Indiana.



Organization Advancements and Community Outreach

Team Members Added

RF has grown this year, adding thirteen new people to the team! They will help accomplish our mission to ensure the electric grid is reliable and secure not just today, but also for tomorrow.



Retention Rate



RF's employees are our greatest asset and we can't be successful without their knowledge and expertise. We also had eight promotions representing 9% of our staff in 2021.

Invested in Training and Development

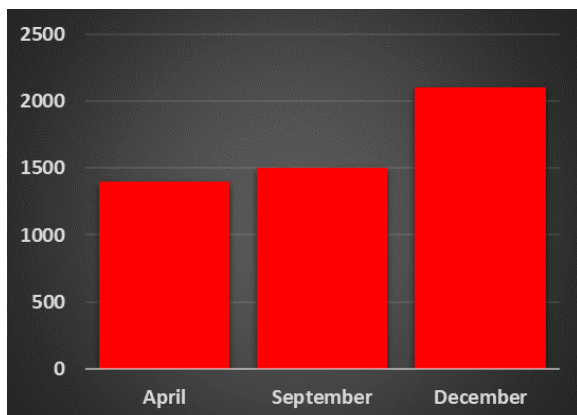
As lifelong learners, we create opportunities for our staff to participate in ongoing training. In 2021, we had a total of 27 training sessions.

Award Winning Culture

RF was voted into The Cleveland Plain Dealer's Top Workplaces in Northeast Ohio for the third straight year!

Community Outreach

RF employees make a difference in our community! Partnering with the Cleveland Food Bank, we packed almost 5,000 lunches for children and seniors in 2021.



Pictured here are some RF team members who volunteered in December.