2020 Annual Gulf Coast Ecosystem Restoration Council Report
Texas RESTORE Centers of Excellence
(October 1, 2019 – September 30, 2020)

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Table of Contents

I. Executive Summary

In January 2015, Texas Commission on Environmental Quality (TCEQ) competitively selected two consortia, the Texas A&M University Corpus Christi - Texas OneGulf Consortium and University of Houston (UofH) - Subsea Systems Institute.

OneGulf

The mission of the Texas OneGulf (OG) Center of Excellence is to gather and improve knowledge about the Gulf of Mexico to inform decision-making around the challenges to environmental and economic sustainability of the Gulf of Mexico and its impact on the health and well-being of Texans and the nation. Texas OneGulf is designed with the capacity and flexibility to address all five disciplines denoted in Section 1605 of RESTORE. This Center has been awarded funding and has begun or completed activities on eight projects, with three currently active. Highlights for this reporting period include: The Stakeholder Communication and Engagement Plan being completed, and the Hurricane Harvey Decision Support and Harmful Algal Bloom Monitoring projects having commenced and made significant progress.

Subsea Systems Institute

The Subsea Systems Institute (SSI) is a Center of Excellence formed under the Restore Act and represents a collaboration between the University of Houston, Rice University and NASA/Johnson Space Center. This Center was awarded funding and has begun or completed activities on ten projects, with three currently active. The SSI focuses on Offshore energy development, including research and technology to improve the sustainable and safe development of energy resources in the Gulf of Mexico. The key outcomes from the work of the SSI for this reporting period include:

- Providing unbiased third-party validation to build public trust in the safety and operation of offshore drilling and production;
- Economically developing and assisting in the deployment of advantaged safest technologies for offshore energy development, and the elevation and ensuring of the energy industry's safety and operational excellence in offshore applications and;
- Becoming the repository for best practices and policies for deployment.

An Advisory Board and a Technical Advisory Committee have been established to support the governance and technical supervision of the SSI. The membership for both committees is on a volunteer basis drawn primarily from industry. These committees support both the strategic planning and the scope of technical work for SSI.

II. Programmatic Elements

Award Recipient

As the Texas Governor's appointee to the RESTORE Council, Toby Baker, Executive Director of the TCEQ, has established two Centers of Excellence in Texas in accordance with the requirements set forth in the RESTORE Act and U.S. Treasury regulations. On behalf of Baker and the Governor, TCEQ has received three awards from Treasury totaling $9,735,488 ($4,036,238 on June 9, 2015, $2,194,350 on October 31, 2017 and $3,504,900 on August 1st, 2020) that address all five disciplines denoted in Section 1605 of RESTORE (1605).

Annual TCEQ accomplishments include:

- Completion of sub-awarding process for two Proposal of Grant Activities to the Centers;
- monitored and reviewed deliverables for each Center;
- responded to inquiries from Centers;
- reviewed invoices and processed eligible expenditure reimbursements;
- generated and submitted required federal reporting;
- held End-of-Year meetings with each of the two Centers to discuss detailed reviews of the progress of each of the projects;
- received an Institutional Review Board (IRB) exemption from Treasury for Proposal of Grant Activities (PGA) Stakeholder Communication and Engagement Plan project (previously titled: Gulf coast Health Alliance: achieving Resiliency Together);
- coordinated prior approval of foreign travel for lower tier sub-awardee for Remote Robotics for Unmanned Human Environments project; and
- conducted site visit at Subsea Systems Institute to see Robotics project and tour labs for Remote High Power for Subsea Emergencies and Hazard Mitigation and Facility Monitoring Program: Fiber-Optic Seismic Systems projects;
- conducted a site visit at Texas OneGulf to see the facility, toured new building and discussed possible upcoming projects.
- Oversight of activities for active projects and close out of twelve of the eighteen projects.

Award Subrecipient(s)

Texas OneGulf Consortium

The nine participants in the Texas OneGulf Consortium include:

- Texas A&M University Corpus Christi, Harte Research Institute for Gulf of Mexico Studies;
- Texas A&M University at Galveston, Marine Biology, Science and Engineering Departments;
- University of Houston Law Center, Center for U.S., and Mexican Law;
- Texas A&M University, Center for Translational Environmental Health Research (CTEHR);
- Gulf of Mexico Coastal Ocean Observing System-Regional Association (GCOOS);
- University of Texas Medical Branch at Galveston, Sealy Center for Environmental Health and Medicine (UTMB);
- Texas A&M University, Geochemical and Environmental Research Group (GERG);
- University of Texas Rio Grande Valley, Biological and Environmental Sciences; and
- Texas State University, The Meadows Center for Water, and the Environment.

1-57790 **General Operations of Center of Excellence** project, principals Dr. Larry McKinney (Harte) and Dr. Jennifer Horney (TAMU), awarded 10/19/15, Scope of Work – This project's task is to establish a fully functional Center of Excellence (COE). Project addresses all five eligible disciplines denoted in 1605. Status of performance and annual accomplishments include:

- Met the reporting requirements of the COE and continues to oversee the day-to-day operations and administration of the COE.
- Developed and implemented a competitive grant program which includes:
  - Design and implementation of a grant portal function with webforms.
  - Completed establishment of grant administration and management system with Texas A&M University Sponsored Research Services.
  - Completed establishment of grant review system within the Texas OneGulf Management Team and Science Advisory Committee.
  - Completed first and second Request for Proposal (RFP) which resulted in approved projects.

2-61593 **Strategic Research and Action Plan (SRAP)** project, principal Dr. Larry McKinney (Harte), awarded 01/07/2016, Scope of Work – This project is to develop a strategic planning process to address priority Gulf problems and guide a grant process that fosters a science-based and solution driven framework addressing the disciplines designated in the RESTORE Act. The project addresses all five 1605

eligible disciplines. The status of performance and annual accomplishments are listed below.

- All tasks, deliverables, and milestones for the project were completed in 2019.
- Future SRAPs will come from an annual cycle of input and review to help ensure that the SRAP evolves with Texas OneGulf as a means of guiding future work plans and focus.

3-62428 **Environmental, Human Health and Safety** project, principals Dr. Larry McKinney (Harte) and Dr. Jennifer Horney (TAMU) replaced Dr. Cheryl Walker

(CTEHR), awarded 02/25/2016, Scope of Work – This project will create a first time infrastructure to support disaster research response encompassing both environmental, human health and economic assessment capabilities that can be employed rapidly to assess the impact of disaster along the Texas Gulf coast in real-time. The project addresses the 1605 eligible discipline of coastal and deltaic sustainability, restoration, and protection, including solutions and technology that allow citizens to live in a safe and sustainable manner in a coastal delta in the Gulf Coast Region. Status of performance and annual accomplishments include:

- Completed all tasks, deliverables, and milestones for the project in 2019.

4-62971 **Mechanisms Controlling Hypoxia** – Gilder Applications to Gulf of Mexico Hypoxic Zone Monitoring project, principals are Dr. Larry McKinney (Harte) and Dr. Anthony Knap (GERG), awarded 04/22/2016, Scope of Work – This project gathered and shared unique data about hypoxia off the Texas coast to assist in the development of a scalable glider monitoring implementation plan for the Gulf of Mexico hypoxic zone. The project addressed the 1605 eligible discipline comprehensive observation, monitoring, and mapping of the Gulf of Mexico. Status of performance and annual accomplishments include

- All collected observations from the eight glider missions were examined and finalized quality assured data sets were placed on the dedicated project web site at http://tabs.gerg.tamu.edu/tceq/
- The infrastructure to quickly assess the impact of both man-made and natural disasters has been completed. It is recommended that a combination of vehicle types (surface gliders and sub-surface buoyancy gliders) be deployed to maximize spatial coverage and temporal duration of the event.
- PI Anthony Knap hosted and participated in the “Prioritizing Public Health Risks from Oil Spills: 2018 Stakeholder Meeting” on 6 April 2018
- The final glider monitoring implementation plan for the DR2 program has been completed
- All tasks, deliverables, and milestones for the project have now been completed

6-70739 **Texas Knowledge Base** project, principals Dr. Larry McKinney (Harte), Dr. James Gibeaut (Harte), and Dr. Matthew Howard (TAMU), awarded 01/18/2017, Scope of Work – This project established the Gulf of Mexico Coastal Ocean Observing System Regional Association’s (GCOOS-RA) and Gulf of Mexico Research Initiative Information & Data Cooperative (GRIIDC) programs as part of the Texas OneGulf Knowledge Base (TOKB) information system. This system provides

decision-makers with the best available science and real-time data and information on which to make such decisions and act to the benefit of Texas. TOKB brings together extensive, complementary, and well-maintained online information systems for marine science, oceanographic and related data currently available from the Gulf of Mexico. The project addresses all five 1605 eligible disciplines. Status of performance and annual accomplishments include:

- The development and launch of the first version of the website was a significant milestone that will serve to establish the TOKB for managing the coast and providing data and tools for addressing future environmental issues
- The coastal Texas Sensitive Areas geodatabase, which includes more than 30 state-wide Texas geographic layers showing the distribution of environments and other ancillary information such as dredged channels and protected areas was compiled
- The first version of the Texas coast literature atlas was launched
- The deliverable requirements for the Knowledge Base data integration products have been completed
- All tasks, deliverables, and milestones for the project have now been completed

7-84395 **Stakeholder Communication and Engagement Plan**, principal investigators Sharon Croisant (UTMB) and Katya Wowk (Harte), awarded 9/21/18, Scope of Work – This project aimed to: 1) provide a stakeholder analysis, with emphasis on policy- and decision makers; 2) solicit broad-based stakeholder perceptions of short- and long-term issues and threats related to the Gulf; 3) analyze the ability of Texas OneGulf and the Texas OneGulf Network of Experts (TONE) to help address these issues; and 4) develop a comprehensive Communications and Engagement Plan for Texas OneGulf based on findings. The project addressed the 1605 eligible discipline comprehensive observation, monitoring, and mapping of the Gulf of Mexico. Status of performance and annual accomplishments include:

- Convened a series of meetings with TONE members (Galveston, Corpus Christi, and College Station) to determine priorities and gaps in research related to: Gulf status and trends, risks and threats, mitigation and adaptation, and recommendations for policy.
- Key informant interviews continued
- Completed final analysis for survey and interview data
- Completed final qualitative analysis
- Completed final report
- All tasks, deliverables, and milestones for the project have now been completed

8-91613 **Hurricane Harvey Decision Support- Resilient Environments and Communities**, principal investigators Katya Wowk (Harte), Yuriy Fovanov (UTMB), and George Golovko (UTMB), awarded 11/14/18, Scope of Work – This research examined the impacts of Hurricane Harvey to help Texas OneGulf provide decision support by: 1) understanding impacts and recovery dynamics of key waterbodies, and potential linkages to community resilience2; 2) understanding socioeconomic

impacts linked with environmental impacts; and 3) providing a framework for recovery that outlines strategic recommendations to improve resilience to future events, identifies gaps in mitigation planning and policy implementation, and provides recommendations to researchers and decision-makers to improve response, recovery, mitigation and data collection in subsequent events. Status of performance and annual accomplishments include:

- Researchers collected water samples to assess microbial communities post-Hurricane Harvey
- Researchers travelled to disaster-stricken communities in the Coastal Bend to assess the degree of alignment in community plans toward the overall goal of disaster resilience and mitigation, in at least two communities.
- Researchers created the survey protocol to conduct stakeholder interviews to assess the importance of relationships through a social network analysis. Researchers also submitted an application to the TAMU Institutional Review Board (IRB) to ensure compliance with 45 CFR 46.118 for research involving human test subjects.
- Researchers conducted legal review of key challenges and consideration for disaster response and resilience in Texas, including identification of any gaps or conflicts.
- Completed Legal Guide on a Texas Disaster Recovery Framework
- Completed final report
- All tasks, deliverables, and milestones for the project have now been completed

9-92349 **Harmful Algal Bloom Monitoring and Assessment Plan** for Texas Estuaries, principal investigators Michael Wetz (Harte) and Andrew Ropicki (University of Florida), awarded 2/25/19, Scope of Work – This project will address two priority needs pertaining to HABs on the Texas coast, including: 1) an immediate need to understand the evolution and drivers of K. brevis blooms and toxin production in estuarine environments where human exposure to algal toxins is most likely, and 2) a longer-term need to develop a comprehensive HAB monitoring program and network in the Coastal Bend region of Texas that will ultimately serve as a framework for the rest of the Texas coast. Status of performance and annual accomplishments include:

- Engaged stakeholders to acquire information on strengths/weaknesses of current harmful algal bloom monitoring efforts in Texas
- Ordered equipment and supplies in preparation for field sampling this fall
- Synthesized stakeholder information
- Drafted HAB monitoring plan
- Next Steps: conduct field sampling if there is an event in the near-term; complete final report on sampling activity; complete HAB monitoring plan and economic analysis

<u>Subsea Systems Institute Consortium</u>

1-57794 **General Operations** of Center of Excellence project. This project covers the overhead and administration costs for the Subsea Systems Institute. This includes part of the overall time and salary cost for the Director and Program Manager.

2-62404 **Remote High Power for Subsea Emergencies**

The goal of this project is to develop a combination of two new technologies using batteries and high-power supercapacitors for subsea applications including the control pod for a subsea blowout preventer (BOP). This work will pave the way for improved energy storage and power supply solutions that enable not only next generation blowout preventers to reliably operate and provide a safer environment for the exploration and production of oil in subsea environments, but to provide electrical high-power for a range of subsea equipment needs. The specific goals are to:

- Design and fabricate high power, high voltage nanoporous nickel fluoride (NP-NF) thin-film supercapacitors;
- Design and fabricate high capacity, thin-film Li ion batteries to trickle charge the supercapacitors;
- Stack and integrate NP-NF thin-film supercapacitors with thin-film Li ion batteries;
- Develop a prototype supercapacitor-battery unit for electrical testing under subsea environmental conditions.

The project commenced with the design, fabrication and feasibility testing of thin-film Li ion batteries and thin-film supercapacitors. The integrated testing of nanoporous thin-film supercapacitors with thin- film Li ion batteries included tests under subsea environmental pressure conditions. Project was completed and final report submitted May 2018.

3-62406 **A Model-Based Real-Time Annular Blowout Preventor (BOP) Monitoring System**

This project is a collaboration between the University Of Houston and Rice University with a focus on real-time health and risk assessment (collectively called condition monitoring) of annular blowout preventers (BOPs). A blowout preventer (BOP) is a large, specialized mechanical device, used to seal, control, and monitor oil and gas wells to prevent blowout, the uncontrolled release of crude oil and/or natural gas from well. A typical subsea deep-water blowout preventer system includes components such as electrical and hydraulic lines, control pods, hydraulic accumulators, test valve, kill and choke lines and valves, riser joint, hydraulic connectors, and a support frame.

This work will produce a BOP Monitoring System capable of self-integration whereby it learns the specific equipment thereby enabling accurate estimations of BOP health. The impact of this work centers on the creation of an Information Synthesis (IS) monitoring knowledge base applicable to a broad range of subsea systems. The proposed IS technology complements the data fusion knowledge by synthesizing information via dynamic adaptive models. Using the adapted model coefficients, BOP health a11d remaining useful life estimations will be recovered in a rigorous mathematical formulation.

Work commenced at the University of Houston on the development of the adaptive, physics-based model. Dr. Matthew Brake, Principal Investigator for Rice University, worked on the finite element modeling of the elastomeric annular for the BOP. Project was complete and final report submitted August 2018.

4-62408 **Marine Drilling Hazard Mitigation and Production Facility Monitoring using Seismic and Sonar Imaging**

Hydrocarbons produced from deep-water regions in the Gulf of Mexico (GOM) are major contributors to the US energy industry and national economy as a whole. Monitoring the drilling process as well as subsequent activity is critical to avoiding accidents and optimizing production.

This project, in the first phase, addressed the areas of early kick detection, wellbore monitoring and subsea processing via subsea monitoring. The project adapts existing seismic technology for surveying geological formations to the specific purpose of monitoring the health of subsea drilling or production systems. The project also develops a proof-of-concept monitoring system for the early detection and assessment of drilling or production problems. The second phase of the project included field trials of the systems. Phase 2 program was contingent on the results of this phase 1 and is not part of this GAD.

The proposed future monitoring system consists of three components:

1. Fiber-optic motion sensors (distributed acoustic systems - DAS) on the riser to monitor hydrocarbon flow and pressure transients. The riser is a flow line from the sea floor to the surface platform and forms part of an existing production facility. There is no funding for this component during the first phase of the project;
2. Ocean-bottom seismometers (OBS) arrayed around the well-head to detect gas and overpressure zones, micro seismic events, and sediment deformation;
3. Active sonar scanners near the BOP to create 3D images of the wellhead vicinity and possible hydrocarbon leaks.

These instruments would continuously monitor and provide information to assess drilling progress, facility integrity, production state, and anomalies. The project will develop a proof-of-concept monitoring system for the early detection and assessment of drilling or production problems. It will thus inform about the design and capability of a full field system which will contribute substantially toward the safety and efficacy of deep-water operations.

The specific goals of the first phase of the project are as follows:

- Host an industry workshop
- Investigate and confirm the application of seismic instrumentation for the monitoring of the integrity of drilling and production systems through the use of:
    - Distributed Acoustic Systems (DAS)
    - Sonar
    - Ocean-bottom seismometers (OBS)

The laboratory work for this project has been completed and the final report was submitted March 2017. A presentation of the preliminary results was given to the Subsea Systems Institute's Technical Advisory Board in January 2017.

5-62412 **Autonomous Underwater Vehicles for Subsea Energy Applications**

Autonomous Underwater Vehicles (AUVs) are emerging with new capabilities and technologies that can make them more efficient and more cost effective than Remotely Operated Vehicles (ROVs) for some subsea tasks in the offshore industry.

The proposed research in the first phase of an overall program, addressed some of the technological challenges. The objective is to develop an AUV prototype that will be highly maneuverable in tight spaces, can hold station vertically, can perform docking, and will be capable of autonomous manipulation. The overall program will advance several aspects of AUV technological challenges in autonomy, sensing, and physical capabilities. Specifically, advances will be made in thruster technology and sensing which will enable high maneuverability in tight spaces. The research approach will leverage advances made by the Robotics & Intelligent Systems Lab at Rice University in swimming robotic inspection of above-ground oil storage tanks, and NASA's robotics, automation, and guidance technologies, and its Neutral Buoyancy Lab infrastructure.

The objective of this initial Phase 1 funding award consists of two levels with a final goal of establishing a future sound and comprehensive program in autonomous AUVs for subsea energy applications with engagement and endorsement of major operators. The specific goals of this project are as follows:

- Program 1: Organize a workshop to engage industry in overviewing the state of the art of AUV technology and build a collaborative relationship with operators in subsea energy applications to define the new challenges of subsea AUVs. The objective is to identify the end user mission requirements, the status of AUV research and technology development within industry and the target areas for defining the future research objectives for this project.
- Program 2: Build an updated, more functional, and more robust version of the Rice University RiSYS Lab swimming robot prototype and tested at NASA's Neutral Buoyancy Lab. In Phase 1 of the project, the robot's hydrodynamic shape (referred to as Problem 1 in the original proposal document), thrusters and their configurations (Problem 2 in proposal), and design of new bidirectional thrusters (Problem 3 in proposal) will not be addressed. This grant funding will be used to build one, updated AUV prototype from the existing unit.

On completion of Phase 1, consideration was given to completing the original scope of work as Phase 2. This would include addressing Problems 1-3 and constructing a second, more complete and capable AUV incorporating these results and technology developments. These will potentially be included in the scope of work in a future phase of the project. Partnership with industry partners will have to be demonstrated for this work to be advanced.

The work to date includes:

- Engagement with industry through SPRINT Users forum as part of the consultation with SSI and NASA to define the upcoming workshop objectives, format, and logistics.

- Construction of updated prototype AUV has begun in the RiSYS lab

The final step included testing of updated prototype at NASA Neutral Buoyancy Laboratory, which was executed in July 2018. Project completed and final report submitted August 2018.

6-74270 **Stress Wave Assisted Communications in Subsea Environments**

This proposal is a collaboration between the University of Houston and the University of Alabama focusing on long distance underwater communication. This work will produce a new, stress wave-based communication method using piezoelectric transducers to be used for subsea communication. Utilizing specially designed sensor nodes, data will be gathered, encoded, and transmitted through subsea pipelines. The scientific impact of this work centers on the installation of sensor nodes as a way to propagate the entire system of subsea pipelines as a web of pathways for stress wave-based communication along the network of sensor nodes. The Gulf of Mexico (GOM) contains a major infrastructure of pipelines and subsea facilities supporting exploration and production activities. GOM operators will benefit from more robust communications resulting in improved real time monitoring capability and a significant reduction in costs related to subsea data transmission.

The mobilization of this project has included work on Task 1, Designing sensor and gateway nodes. Simulation results show that leveraging stress wave communications in hybrid subsea wireless network can significantly improve the overall network performance. The integration of the stress wave and acoustic communications and development of the protocol stack for stress wave communication has been completed. Recent activities include:

- Underwater acoustic testing using distributed fiber optic sensors and piezoelectric transducers
- Realtime Demodulation of Stress Wave Signal in LabVIEW
- Transducer Fixture Design and Implementation
- Further Analysis of Wave Propagation in Pipe Structures
- Mode Analysis of Current Pipe Geometry
- Acoustic Experiments in Gulf of Mexico
- Project was completed and final report submitted September 2019.

7-74785 **Hazard Mitigation and Facility Monitoring Program: Fiber-Optic Seismic Systems**

In the Gulf of Mexico, there are some 25,000 miles of pipelines crisscrossing the seafloor and about 3,000 producing wells with their associated platforms (Edelstein, 2015). The Gulf currently produces approximately 20% (1.7 million barrels of oil per day – EIA, 2016) of the US oil total. The overall goal of this project is to develop vibration monitoring systems to improve the safety and cost-effectiveness of subsea petroleum monitoring and production. Anything that compromises this activity can have serious economic or environmental consequences. Wells and pipelines can be subject to untoward events or processes (e.g., corrosion, plugging, leakage, storms, and seafloor instabilities). Thus, monitoring oil and gas flow in pipelines (and risers and sub-bottom casings) is

critical to assess conduit integrity and as well as optimize overall production performance. This proposal focuses on reservoir characterization, underwater communication, and infrastructure integrity assurance. This work will develop a proof-of-concept marine, fiber-optic vibration sensing system – an instrumented flow loop for the lab and field. Along with associated analysis and interpretation methods, this system will provide learnings for improved subsea reservoir monitoring and production. Industry support will come in the form of collaborations with Apache Corp., Lawrence Berkeley National Laboratory, Optasense and Halliburton.

This project initiated each task including the building of the pipeline flow system, measuring the response of fiber-optic sensors, performing flow and seismic tests in marine environments, and testing at the LaMarque, Texas site through a 100' well and 200' trench horizontal stretch and assessment at the bayou.

Project was completed and final report submitted April 2019.

8-84091 **Remote Robotics for Unmanned Human Environments**

The principal objective of this project is to provide baseline proof-of-concept evidence that robotic assets can perform tasks normally done by humans in complex oil and gas/or space relevant environments. The project team in concert with an advisory council comprised of energy operations experts, the NASA Principal Technologist for Robotics, and other subject matter experts will ensure that robot task development and proof-of-concept tests are properly aligned to the needs found across the oil and gas sector, existing and future NUIs (normally unmanned installations), and potential space exploration assets.

The secondary objective of this project is to increase the effectiveness of remote robotic systems operating in human-centric environments and reduce the cognitive burden on their remote human operators.

Recent project activities include the mobilization of the tasks in the first quarter to establish personnel and begin process for industry robotics advisory panel to develop a roadmap for near-term achievements by robotic systems in the energy industry with input from NASA robotics subject matter experts. The roadmap provides candidate tasks to be achieved by the robots used in the project. The specific tasks identified are:

1. Advisory Council Kick-Off Meeting (complete)
2. SmartTouch and Valkyrie Integration (commenced)
3. Collision Avoidance in Subsea (commenced)
4. Interfacing Robots and Oil Rig Platform Doors (complete)

9-93274 **SmartTouch: Towards Autonomous Subsea Robotics for Underwater Pipeline Inspection**

The main objective of this project is to develop transformative robotic and SmartTouch sensing technology, that will lead to a time efficient and cost-effective system for underwater pipeline inspection. Through this autonomous robotic system equipped with SmartTouch pipeline anomalies due to bolt loosening, seismic activity, offshore drilling, turbulence, and ship anchoring, may be detected at early stages and thus allow operators to make informed decisions on

maintenance of the pipeline. The following tasks will be investigated to achieve the objective:

1. SmartTouch sensor development (complete)
2. Robotic manipulator development (complete)
3. Force feedback grasping control (complete)
4. Systems integration (complete)

This project has been mobilized with the sensor development and integration, energy-based monitoring methods, a completed robotic manipulator and force feedback grasping control. The modeling of the connection interface and integration of the robotic manipulator with ROV and demonstrations has been completed. Next steps will be to submit final reports.

10-93275 **Flexible Low-Temperature Lithium Ion Batteries for Subsea Applications**

The main goal of this project is to design and fabricate polymer-based flexible and safe lithium ion batteries able to operate under subsea conditions. Potential applications include powering devices in underwater vehicles, emergency outage backup power, and subsea drilling structural energy storage. The device should be reliable, safe, and able to instantly provide power for subsea applications. This work will pave the way for novel and improved energy storage solutions such as flexible batteries for subsea applications and expand their electrochemical performances, allowing the batteries to operate at temperatures as low as 0o C. This device will reliably provide a safer environment for the exploration and production of oil in subsea conditions, and to deliver high-power for a range of subsea needs. The specific goals of this project are the following:

1. Design/Fabricate LIBs (Steady and Long-Term Power Voltage at Low Temperatures (complete)
2. Boost the Performance of LIBs (complete)
3. Develop Electro thermal Model and Conduct Simulation at Low Temperatures (complete)

This project initiated each task including the Design/Fabrication of the LIBs, the boosting of the performance of the LIBs through feasibility testing, characterization and performance optimization, development of the electro thermal model and conducting simulation at low temperatures. Prototypes were assembled and tested using the new fabricated polymer and a thermos electrochemical model was developed and simulations were conducted. Final reports were submitted April 2020.

III. Financial Elements

A. Award Recipient

During this reporting period, TCEQ has drawn down funds and obligated project funding to the Centers for grant one:

- $6,230,588 awarded from Treasury, TCEQ has drawn down $4,973,750.15 (79.8%) for expenditures
- $2,323,887.47 of $3,018,119 has been reimbursed to Texas A&M University Corpus Christi - Texas OneGulf
- $2,504,845.51 of $3,018,119 has been reimbursed to University of Houston - Subsea Systems Institute (SSI)
- 145,017.17 was expended for TCEQ management and oversight

On August 1, 2020 Treasury awarded a second grant under the centers of Excellence in the amount of $3,504,900.

B. Award Subrecipient(s)

Center	Project	Awarded to Center	Expended	Lower Tier Subawardee	Awarded to Subawardee
Texas OneGulf	1-57790	$764,235	$761,770.18	Amazee Texas A&M (CTEHR)	$ 21,451 $167,036
Texas OneGulf	2-61593	$139,041.78	$139,041.78	N/A	$0
Texas OneGulf	3-62428	$313,504.00	$182,531.99	Texas A&M (CTEHR) University of Texas (UTMB)	$171,639 $133,365
Texas OneGulf	4-62971	$457,361.00	$392,622.77	Texas A&M (GERG)	$457,361
Texas OneGulf	6-70739	$389,443.00	$318,733.86	Texas A&M (GCOOS)	$194,998
Texas OneGulf	7-84395	$94,759.00	$79,099.69	University of Texas (UTMB)	$64,330.51

Center	Project	Awarded	Expended	Lower Tier Subawardee	Amount
Texas OneGulf	8-91613	$470,265.00	$313,465.24	University of Texas (UTMB) Texas A&M (Bush) Texas A&M (ISC) University of Houston	$207,660.92 $75,571.64 $40,217.67 $71,339.65
Texas OneGulf	9-92349	$221,421.00	$136,621.96	University of Florida	$0
SSI	1-57794	$802,184.00	$755,891.77	N/A	$0
SSI	2-62404	$293,032.07	$293,032.07	Rice University	$150,000.00
SSI	3-62406	$175,130.86	$175,130.86	Rice University	$99,330.00
SSI	4-62408	$109,868.74	$109,868.74	N/A	$0
SSI	5-62412	$99,999.86	$99,756.67	Rice University	$92,000.00
SSI	6-74270	$300,000.00	$274,544.33	University of Alabama	$40,075
SSI	7-74785	$248,056.46	$248,056.46	N/A	$0
SSI	8-84091	$714,028.00	$480,823.90	BayTech Rice University Allen Energy Northeastern University	$20,000.00 $20,432.00 $100,000.00 $20,000.00
SSI	9-93274	$40,000.00	$32,523.04	N/A	$0
SSI	10-93275	$39,997.00	$35,217.67	N/A	$0

IV. Gulf Coast Ecosystem Restoration Council Element

A. Leveraging Multipliers

Texas OneGulf Consortium

1-57790 Total other funds for this project is $28,519 from the Harte Charitable Foundation and Harte Research Support Foundation to assist in with the important task of establishing the center and having it operational as soon as possible. The goal of Harte Research Institute (HRI) is to allow more money to be put toward research by providing additional funds that reduce the center's burden of administrative costs.

Coordination between RESTORE Centers of Excellence

Texas OneGulf has played a leading role in establishing coordination between both designated and presumptive COE's. There is a monthly call between the Centers, where the focus has been on joint research activities.

The Gulf Restoration Science Programs Ad Hoc Coordination Forum, hosted by the NOAA RESTORE Science Program, provides a venue for all Gulf science programs to come together to develop common data management, share funding opportunities and look for synergies and activities that can be shared. The Texas OneGulf Executive Director and Coordinator participates in the monthly call and attends events like Gulf of Mexico Oil Spill and Ecosystem Science Conference (GOMOSES). These face to face meetings serve to enhance coordination and joint actions, reduce duplication and afford opportunities to leverage individual actions.

In addition, Texas OneGulf collaborated with the NOAA RESTORE Science Program to hold a knowledge co-production workshop for Texas researchers and state and federal decision-makers. The workshop helped to strengthen coordinated research toward the production of usable, actionable science that meets RESTORE program needs.

The Texas OneGulf Executive Director also serves on the Friends Board of the Florida Institute of Oceanography, providing additional opportunities for coordination of COE funding. This Board also acts as part of the Florida COE Management Team and provides review and approval for funding FLRACEP projects. The management team looks for opportunities to minimize duplication and promote coordinated research.

Subsea Systems Institute

The Subsea Systems Institute has secured the grant with the Office of the Governor (OOG).

The following activities have taken place under the award from the OOG:

- **Research Programs:** This includes research programs that have not been included in the programs funded by TCEQ. These programs are in the following categories:

- Programs identified through the TCEQ grant award process, but not funded by TCEQ, which are identified as valuable research topics that meet the SSI objectives;
- Research topics that are identified through SSI engagement with industry or the government that meet SSI objectives including safety, risk mitigation and improved reliability.

- The following **Research Programs** have been launched:
  - Pilot project to develop new computational methods for hydrocarbon behavior in a marine riser.
    - The Principal Investigator on this project is Dr. Andrea Prosperetti (UH). This project has undertaken a theoretical and computational study of the character of hydrocarbons that are inadvertently introduced into a marine riser. This issue has been discussed with industry and the need for new methods and understanding has been identified in order to establish improved operating procedures. Current project status includes a newly developed algorithm and has been successfully applied to a set of equations. This work may be extended through programs to be awarded by the Bureau of Safety and Environmental Enforcement (BSEE) and the Gulf Research Program (GRP). The value of the pilot program is $50,000.
  - Demonstration project with industry partner The Jukes Group, to develop improved manufacturing and testing methods to predict the performance of API pipe flanges under a combination of loading conditions.
    - The Principal Investigator on this project is Dr. Gangbing Song (UH). This work will improve the leak performance of pipe flanges, as is a major topic for operators. In September 2017 a meeting was held with industry operators to engage in discussions to focus the testing of the flange in a way that would most benefit the industry and make improvements to industry standards. A follow up meeting was held with joint industry project interested industry operators in May 2018 to discussion the preparation of a proposal to fund phase II. Current project status includes the writing of the proposal and planning of the demonstration testing. The cost of this demonstration project is $41,731.
  - Development project of High-Power Density Fault Tolerant Subsea Drives with Advanced Circuit Breaker to support the ongoing development of the power requirements for subsea equipment.
    - The Principal Investigator on this project was Dr. Kaushik Rajashekara (UH). The first year of this project was be supported by the grant funds. There were a number of technology components to this program:
      - The development of advanced power converter topologies using high frequency magnetics to reduce the footprint of subsea and down-hole drive systems:

- Real-time simulation of the entire subsea system to evaluate the harmonics, to study the effects of long-distance cable capacities and voltage stability.
- The project also targets development of a novel solid-state DC circuit breaker and connector suitable for subsea systems.

▪ The project launched in September 2017 and laboratory personnel were established and a database was developed. Current project status includes testing and extracting data and experimental results have been verified and shown the capability of the proposed circuit performance. In the coming months, the thermal cycling test board which have already been designed, will be implemented and a high-temperature SiC-MOSFET and high-temperature gate driver will be installed, and tests will commence in high-temperature. The cost for the first year of research project was $148,000.

GADs that include leveraging multipliers are listed here:

- 2-62404 Remote High Power for Subsea Emergencies:
  - Dr. James Tour (PI) provides supervision for work being done on the project at Rice as delineated in the SOW and proposal. His annualized salary is $129,272.00. His contribution to the project over the 22 months will be 1 month each year (12 months).
    - Year 1: PI salary was provided from the Rice University (non-federal local) (1 month).
    - Year 2: PI salary was be provided from the Rice University (non-federal local) (1 month).
    - This amount includes a 3% merit increase.
    - Fringe Benefits are actual and is estimated at about 30% for faculty
- 3-62406 Model-Based Real-Time Annual Blowout Preventer (BOP) Monitoring System:
  - Dr. Matt Franchek (PI), with an annualized salary of $279,600, dedicated 1month effort to manage the UH portion of the work.
    - Year 1: $13,255.00 was paid by the University funds (state appropriations) for .5 month in the academic year.
    - Year 2: $13,255.00 was paid by the University funds (state appropriations) for .5 month in the academic year.
    - Fringe Benefits are actual and is estimated at 16% in the summer for this faculty.
  - Dr. Brake (Co-I) will supervise the work to be done on the 22-month project at Rice as delineated in the SOW.
    - Year 1: $10,946.94 will be paid by the University funds (non-federal local) for .4-month in the academic year.

        - Year 2: $11,095.01 will be paid by the University funds (non-federal local) for .4-month in the academic year.
        - Fringe Benefits rates for this faculty is 23.40%.
    - Use of a testbed, which is a Transocean test facility, is made available to this project at no cost. The approximate market value for access to this test equipment is $10,000 per year.

- 4-62408 Marine Drilling Hazard Mitigation and Production Facility Monitoring using Seismic and Sonar Imaging:
    - Dr. Rob Stewart (PI), with an annualized salary of $281,856.00, has dedicated .6-month in the summer (20%) and .5-month academic time (6%) to manage the work.
        - Year 1: $14,129.00 of the PI salary was provided by the grant and $11,744.00 by the university.
        - Fringe Benefits are actual and is estimated at 30% in the academic year for this faculty and 22% in the summer.
    - Jiming Bao (Co-I) with an annualized salary of $137,592.00, dedicated .4-month summer (13%) and .5-month academic time (6%) to work on the project.
        - Year 1: $4,610.00 of the Co-I salary was provided by the grant and the other $5,733.00 by the university.
        - Fringe Benefits are actual and is estimated at 30% in the academic year for this faculty and 22% in the summer.

- 5-62412 Autonomous Underwater Vehicles (AUV) for Subsea Energy Applications project:
    - Dr. Fathi Ghorbel (PI) oversees the statistical analyses, data management, and be responsible for reporting the project's results.
        - Year 1: The PI devoted 2 months effort to the project. One-month salary was provided from the grant funds and one-month funding was provided by Rice University (non-federal funds).
        - Fringe Benefits 23.4% for faculty.
    - The use of an existing prototype AUV represents an in-kind contribution (Estimated amount $10,000.00).