Quarterly Report – Public Page

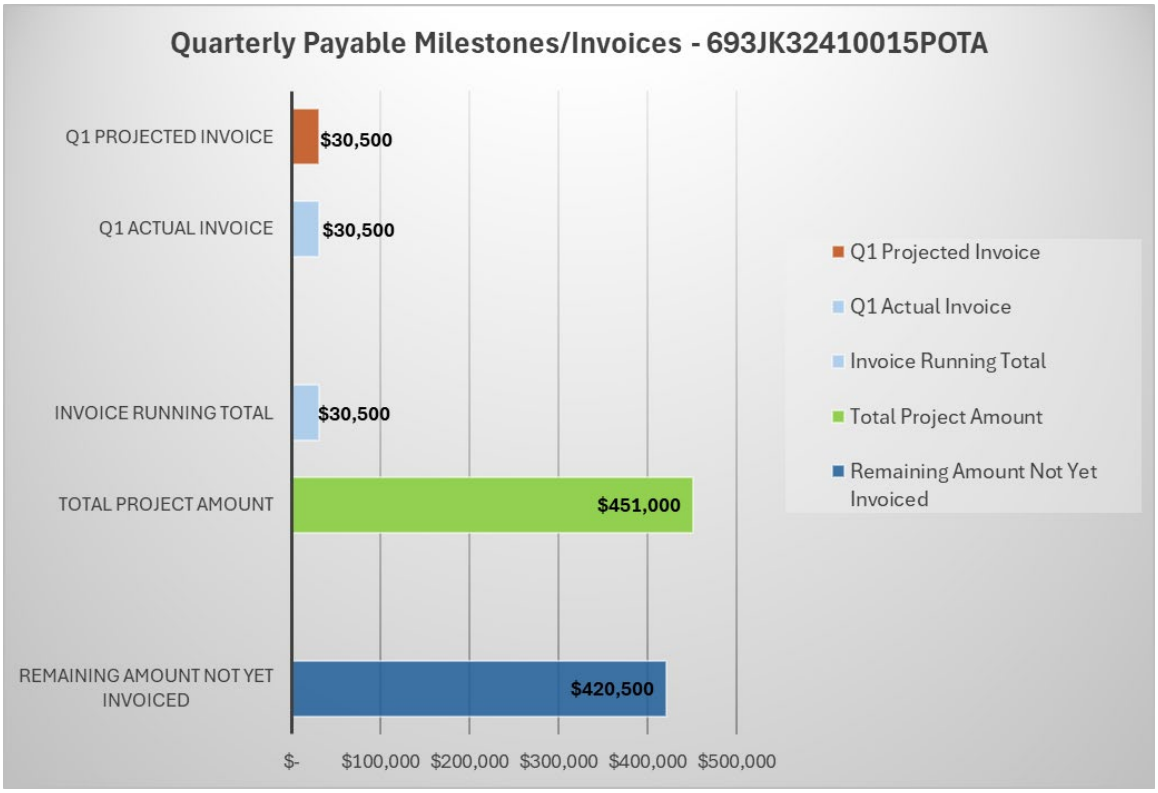
Date of Report: *1st Quarterly Report-December 31, 2024*
Contract Number: *693JK32410015POTA*
Prepared for: *DOT-PHMSA*
Project Title: *In-situ Rapid-Cured-in-Place Pipelining System for Rehabilitation of Metallic Gas Pipe*
Prepared by: *RapiCure Solutions*
Contact Information: *Heather Rubin, Team Project Manager, heather@rapicuresolutions.com*
For quarterly period ending: *December 31, 2024*

1: Items Completed During this Quarterly Period:

Item #	*Task #*	*Activity/Deliverable*	*Title*	[redacted]	[redacted]
3	*2*	*Literature review*	*Literature review*		
4	*10*	*Suggest improvements*	*Suggest improvements Q1*		
1/2	*1/13*	*Team meetings and kick off meeting*	*Team meetings and kick off meeting*		
5	*14*	*1st quarterly status report*	*1st quarterly status report*		
6	*3*	*Develop coating Part 1*	*Develop coating Part 1 – 1' liners (4)*		
7	*3*	*Develop coating Part 2*	*Develop coating Part 2 – 4' liners (6)*		
8	*3*	*Develop coating Part 3*	*Develop coating Part 3 – Optimized liner*		

2: Items Not-Completed During this Quarterly Period:
Project is on time in Q1, and ahead of schedule for planning and development of tasks 6 and 7 (Q2 and Q3).

3: Project Financial Tracking During this Quarterly Period:



4: Project Technical Status –

[Item #3] [Task 2][Literature review][Literature review]

A thorough literature review has been conducted and tabulated below. As noted in Attachment #2, number 2 this deliverable included a review of relevant research efforts to assist in achieving the project goals to avoid duplications and complement what already exists. The pertinent literature review as well as patent search showed no duplications to the technology presented herein. The information provided in the literature table below includes publicly available information. The most closely identified system is Materia's thermoset polyolefin system. While the polymer backbone is similar and offers similar performance to RapiCure, there does not appear to be a quick curing system like RapiCure's. In addition to the tabulated information, RapiCure conducted additional customer discovery/industry outreach. Key outreach conversations with pipeline owners/operators confirmed that pipeline replacement costs are estimated at >>$1M/mile. A corrosion coating company indicated that $20M of coated pipe would prevent $200M in replacement pipe costs. The corrosion coating company also provided key insights to successful pipeline coatings, treatments, and spraying formulation and applicator options (approx. $40K for sprayer purchase may be an applicator option).

Literature Review
Introduction

RapiCure's motivation for pursuing this project is to bring together the necessary entities to generate a high-performing, cost-effective, and rapid curing solution for internal pipe repair. Over 2,000,000 miles of gas and hazardous liquid pipelines span the US. Over 30,000 of those miles of pipeline require repair or replacement to meet current safety standards. Currently, pipeline repair and repurposing costs more than $1M/mile and often uses cure-in-place pipe (CIPP) solutions or liners. The CIPP or liner strategies utilize resin, commonly epoxy or polyurethane, to generate a plastic or composite sleeve inside a damaged pipe, respectively. In both cases, a major bottleneck to expediting repair is the time required for legacy thermoset resins to cure, which can take 4-48 hours, or more, depending on ambient temperature. To understand the existing CIPP landscape and legacy solutions, RapiCure performed a deep analysis of commercially available CIPP solutions.

Methods

A literature review was performed of the existing commercial landscape. The results were tabulated in the table below. All data was pulled from company websites and only what was publicly available was supplied. AlphaSense and Google Scholar were used with the search terms "CIPP", "SIPP", "cured-in-place-liners". Additionally, "cipp-service-operator" was searched, and technical product sheets were screened. Large reports were found (see example attached in appendix 1) and analyzed around the success, failures and product offerings.

Results

Table 1 below was used to tabulate commercially available CIPP technologies based on publicly available data. To this end, the company name was identified, key value propositions, products, outcomes, material stream, return to service times, applications times, and costs were tabulated when available.

Table 1. CIPP Solutions

Company	Industry	Material	Key Propositions	Products	Outcomes	Stream	Return to Service Time	Application Time	Cost Total
Saertex MultiCom GmbH	Wastewater, water, gas	UV-Cure Fiberglass Reinforced, UP resin	1 - ready-to-install GRP pipelines for sewer and pressure rehab 2 - Saertex-Liner Environment styrene free, trenchless stormwater repair 3 - Saertex-Liner industry trenchless repair using vinyl ester and ECR fiberglass 4 - Creep tendency after 24-hr <6% (approx.) 5 - Several Type S+ applications (high pressure app.)	1 - GRP liner wastewater, liner supply, equipment for GRP pipe liners 2 - Saertex-Liner Multi: sustainable solution	Primary focus on wastewater, trenchless repairs. Consultations, assistance with bids/onsite support	Water, Wastewater, Gas	-	1 - "FastPlus" saves 1 hr installation time for every 100 meters of liner	-
Waterline Renewal Technologies Inc.	Municipal, Commercial, Industrial, and Residential Applications	Vinyl Ester Resins, Vinyl Hybrid Resins, Epoxy	1 - Provides trenchless pipe repairs through products, tech, and services preventing inflow and infiltration of potable water and wastewater 2 - technologies comprise of conshield, mortars, coatings, connection liners, lateral liners, additives, mainline liners, installation equipment, trailers, UV casting systems	1 - Perma-Liner pipe liner, heat cure equipment, trailers, robotics, perma-lateral inverters 2 - vinyl ester resins, vinyl hybrid resins	1 - Several different applications, focused on the prevention of inflow of wastewater and potable water. 2 - Stiff competition in the market, but good technological advancements	Potable Water, Wastewater	-	5 hours (perma-liner)	-
United Felts (MaxLiner)	Trenchless Pipeline Repair	Felt and Fiberglass CIPP Liners, PU, PE, PP resin	1 - Every aspect of production (material procurement, final coating) is all accomplished via United Felts 2 - "Cost-effective," used in restoring sanitary sewer laterals, storm drains, vertical pipes	1 - MaxLiner Systems, lining material, parts & accessories, hands-on training for CIPP 2 - Curing equipment (heat gun, UV) 3 - Comprehensive CIPP solutions (all inclusive)	1 - Company success closely tied to sewer rehab and repair 2 - Narrow focus on CIPP liner manufacturing	Potable Water, Pressure Pipe, Gravity Sewer Lines	-	-	1000-8000$
Vortex Co LLC	Water, Wastewater, Infrastructure Repair. Municipal, Geo-Technical, Industrial, Commercial, Residential	Epoxy, methacrylate, silicate	1 - Includes resin/liners etc. but also offers condition assessments, manhole rehab service, pipe rehab service, engineering/infrastructure repair, CIPP lining service, geopolymer lining service,	1 - Specialty coatings and equipment 2 - Pipe liners for CIPP applications 3 - Robotics/installation equipment, contracting services and field support 4 - Both UV and	1 - Vast range of products, services 2 - Limited focus on sustainable product development	Water, Wastewater, Infrastructure	-	1.5-4 hours, one 10 min cure option for UV	-

				nominal cure methods					
NuFlow Technologies Inc	Water, gas	Epoxy	1 - Owns/operated NuFlow-certified contractors 2 - Engineers various products for diverse applications, but also supplies certified contractors 3 - Green technologies used to restore inner infrastructure of failing water piping systems 3 - Cold-cure system; unaffected by high or low ambient temps	1 - Sewer and drain linings (NuDrain) 2 - Lining technologies for specialty pipe systems (NuFlow) 3 - Potable water pipe lining (NuLine)	1 - Hosts a wide range of solutions 2 - Limited geographic diversity; region specific	Wastewater, Potable Water, Specialty Pipe Systems (HVAC, fire suppression, chilled water, lead pipe rehab, water risers and mains, grey water, compressed air, conduit piping)	10 min after cure is completed	10-min cure time Lining process 2-8 hours	-
Trelleborg AB	Wastewater, water, gas and oil	Epoxy, glass fiber reinforced, PU coating	1 - Specializes in development, manufacture, and sale of engineered polymer solutions for sealing, damping, and protecting critical applications. 2 - Anti-Vibration technology for motor vehicles/industrial equipment	1 - hoses, elastomers, expansion joints, v-belts, vibration-dampers, sealing profiles, pipe seals 2 - Trenchless pipe rehab resin systems 3 - PipeCure CIPP liner	1 - Worldwide presence, but poor cost efficiency 2 – Acquired several businesses enabling access to a wider field. 3 - Risks related to litigations	Wastewater, water, oil and gas	-	-	-
Sanikom d.o.o.	All? Company is a distributor of liner solutions and resins	Epoxy, PE felts,	1 - Specializes in developing and marketing solutions and materials related to pipeline maintenance 2 - Provides inline repairs, sectional repairs, and various equipment	1 - InLiner Repair, sectional repair, equipment, inflatables 2- Epoxy resin systems 3 - CIPP Inversion liners, main line liners, accessories	1 - Producer of high quality products, however limited product portfolio 2 - opportunity to partner with other businesses	several	-	Pot life is much shorter than full cure time, 3 hr - cure time, 8-hr cure time, 18-hr cure time EX2-2. 30-45 min cure time	-
Brawo Systems GmbH	Real Estate, Construction	Epoxy	1 - Rehab of property and building drainage systems 2 - Products and services in three categories; Brawoliner, Brawo Tech, and Brawo Academy	1 - Seamless textile liners 2 - Training courses in property/building damage 3 - Lots of resins	1 - Works with all 4 curing methods, good with pipe-dimensional challenges (e.g. 90* bends) 2 - growth is limited to the European market- less growth in other markets. Government	Wastewater	-	2hr cure time, 35 min cure time for fast silicate resin, 24-hr cure time, 18 hr cure time	-

					regulation challenges				
ReLineEurope GmbH	Wastewater, water	Glass Fiber Reinforced Plastic (GRP), UV Technology	1 - Trenchless pipeline repair through UV systems	1 - Provides Alphaliners and UV systems 2 - maintenance, academy, construction, rental park, consultancy services	1 - Heavily reliant on the Asian market 2 - wide geographic presence for pipeline rehab	Wastewater, construction	-	-	-
Relining Group International Oy	Spray lining solutions industry	Polyurethane, polyurea	1 - In-house sewer pipe repair, spray application 2 - Spray coating applications, with widespread distributor network in several countries	1 - Various spray pipe coating solutions for in-house repairs (trenchless) 2 - ElastoFamily, a full spray-in-place pipe rehab solution for internal pipe coatings 3 - HelpoFamily, full-brush coating pipe rehab solution for internal pipe coatings 4 - Complementary Equipment for SIPP lining repair	1 - Technological expertise, but paired with a dependence on a specific industry	Wastewater	-	-	-
QuakeWrap Inc	Infrastructure repair and renewal	Fiber reinforced polymer (FRP)	1 - PileMedic and PipeMedic repair systems field-proven to rehabilitate 2 - According to them, are 3x strength of steel	1 - Wraps, adhesives, and coatings 2 - PileMedic and PipeMedic repair systems	1 - USDOT PHMSA featured SuperLaminate project… winning a lot of grants etc.	-	-	7 day cure time	-
Reline Solutions Pty Ltd	Pipe Relining and Drain Repair	-	1 - Focused on blocked drains, plumbing inspections, and pipe relining solutions. 2 - Provider for the actual service, unknown if repair materials is included or not 3 - Uses Brawoliner systems for repair	1- blocked drain repair 2 - pipe relining 3 - drain plumber 4 - drain repair services 5 - SE Qld used to reline cracked pipes, uneven drains, broken drains, holes in pipes, sewer pipes, etc.	1 - Fairly certain this company only provides services (not seeing liners etc. separately)	-	-	-	-
Roto-Rooter Group Inc.	Water and wastewater		1 - plumbing provider and connecter 2 - addresses a myriad of water/wastewater solutions for homeowners and commercial buildings/public works 3 - basic solution people find when looking for a plumber	1 - emergency 24/7 full-service plumbing solutions 2 - connects plumbers to customers 3 - various solvents/chemicals for drain clog prevention	1 - unknown what resin/repair system is used by rotorooter 2 - company is more of a service provider than distributor of relining solutions	-	-	-	-

Sekisui Chemical Co Ltd	Chemical (but also makes pipe stuff and a lot of stuff)	PE, PVC	1 - Chemical company specializing in production and dist. Of plastic and other chemicals. 2 - Urban Infrastructure & Environmental division of business focuses on the pipes. High Performance Plastics division of business also plays role in high impact resins. 3 - Trenchless pipe repair is steel reinforced with the polymer too	1 - "no chemical" liner that does not require curing etc. 2 - SPR Method - trenchless pipe repair	1 - Japanese market is primary source of revenue, however this company is extremely diversified in the products sold.	Wastewater	-	No cure	-
Aegion Corp (Azuria)	-	-	1 - Primary focus in rehab of pipelines, refineries, other infrastructure 2 - range of brands; Insituform, Underground Solutions, Corrpro, Environmental Techniques, EN-TECH Infrastructure, C&L Water Solutions, Culy Inc., etc..	1 - Potable water rehabilitation service and products for CIPP 2 - Spray-in-place pipe, UV CIPP	1 - Very strong portfolio, but most revenue is from the domestic market	Wastewater, potable water, gas	-	-	-
RPB Inc. (Perma-Liner Industries LLC)	Wastewater, sewer, water	-	1 - Provides repair and installation services, in addition to the CIPP liners	1 - Sewer lateral repair (Perma-Lateral System) 2 - Sewer mainline repair (perma-main repair system) 3 - Sectional Point Repair (pull in place manhole to manhole) 4 - UV Lateral Inversion 5 - UV Spot Repairs	1 - High focus on customer satisfaction, but primarily dependent on the US market	-	Sectional point repair pull-in-place manhole to manhole, 1-5 installations per day	Ambient cure 3 hr, 20 min with steam cure.	-
ISG Infrastructure Services Group, LLC	Wastewater, Potable water	people	1 - Specialize in inspection, repair, and rehabilitation of water and wastewater infrastructure systems 2 - partnered companies work together for repair solutions (inspection, repair, and rehabilitation)	1 - Rehabilitation services (inspection, repair, rehab) 2 - service provider instead of distributor	1 - service provider group consisting of ~6 companies 2 - reliant off of other companies	wastewater, potable water	-	-	-
Allan Edwards	oil and gas	Steel, concrete	1 - Leverages industry experience as a primary benefactor for customers 2 - concrete weights	1 - Steel repair sleeve instead of resin 2 - Compression sleeve for pipes to PREVENT	-	gas	-	-	-

			for pipelines offers a cheap and quick solution for pipeline stabilization etc.	damage and cracking					
Silver Lining Pipelining Technology	Water and wastewater	Epoxy (other polymers)	1 - utilize the felt pipe liners/ inversion liners that are impregnated 2 - technical knowledge behind which application and what resins should be used. 3 - Uses "Advanced European Technology to clean and line 1/2"-24" diameter pipe 4 - Provides CIPP lining solutions, but ALSO has spray applications	1 - SilverSteam - epoxy product temp range of 300+ degrees. Ceramic particle loading in epoxy 2 - Products that repair leaks, repair corrosion and other anomalies, increase flow rate 3 - Provider for repair- no ta distributor for liners	1 - Appears centralized to the NY and MD areas 2 - Dependent on the NY and MD market leaves room to expand in other states 3 - Largest projects involve apartment/commercial buildings, with some public work repair	wastewater, water	1 hour post resin application - direct application such as risers. Heavier applications of epoxy cure 4-8 hours	-	50-75% less expensive than traditional pipe repair
SPT Ohio (Specialized Pipe Technologies)	Drain, Sewer, industrial and residential	Epoxy	1 - Primarily technologies revolve around trenchless technology 2 - focuses on Inspection, Cleaning, and Repair services. Does not directly distribute liner solutions, provides the entirety of the service including the liner 3 - Liner works on "all major types of piping materials" 4 - CONNECTED to NuFlow and NuDrain	1 - Epoxy barrier coating 2 - Inspection, Cleaning, and Repair 3 - Repair technology included in actual final repair.	1 - Widely centralized market in central and northeast Ohio 2 - "…fraction of the cost of replacing your whole system"	Water and wastewater	-	-	-
PRS Pipe Restoration Solutions	Sewer pipes	Epoxy	1 - Central focus on the entire pipe rehabilitation process utilizing pipe liers saturated with epoxy 2 - leverages expertise as main benefactor	1 - Inspection, Cleaning, Repair and Rehabilitation 2 - utilize camera technology for inspection, several different cleaning methods and options, trenchless, drain/sewer, and roof drainpipe lining repairs	1 - Located in CA and FL, offers services nationwide 2 - due to localization of offices, less outreach to areas outside of CA and FL	Wastewater, potable water, HVAC chiller lines, fire suppression	-	-	-
Inliner Solutions	Wastewater, stormwater, potable water	Epoxy, geopolymers	1 - Connected company through Puris, uses expertise team to determine a pipe strategy guide for rehabilitation 2 - 1 of 6 lining solution companies under Puris 3 - Service that connects customers to pipe repair	1 - trenchless technologies including mainline and UV CIPP applications, pressure pipe rehab, lateral applications, and a few more lining solutions for other	1 - focus in partnership allows for more lifelong available work (Puris Company) 2 - located more eastern US and Canada. Provides service nationwide, but localization of company/ies	Wastewater, Stormwater, Potable Water	-	-	-

			solutions- Liner Products (puris company) provides liners, Inliner solutions use liners to repair, use expertise to guide, etc.	wastewater applications	might hinder company progress				
Elite Pipeline Services	Water, municipal, gas	fiberglass, 100% solids polymeric material	1 - WBE verified service providers 2 - CIPP and SIPP applications at several diameters 3 - oversees manufacture of CIPP liners 4 - experienced pipeline repair personnel for CIPP, SIPP internal joint seals, coatings, NDE, drain inspections & pipeline cleaning service 5 - Nuclear and industrial experience- lots of emphasis on the nuclear-side of repair 6 - "~80% of failures result due to improper surface preparation"	1 - entire process of CIPP installation- from the manufacture to the installation 2 - CIPP repair, drain inspection, pipeline rehabilitation, pipeline cleaning services, internal pipe joint seal repair 3 - UV cure liner options	1 - service nationwide US 2 - Emphasizing on the nuclear field may close the company off to other opportunities in other fields of pipe repair	water, municipal, gas, nuclear	-	-	-
National Liner	Wastewater, potable water, gas	nonwoven polyester felt liner + thermoset resin (polyester, vinyl ester)	1 - Connects customers with contractors supplied by national liner 2 - combined products from other companies for repair supply, provides the service providers with the material to provide CIPP to customer	1 - Sources fabric liner from certain companies, resin from other companies including Interplastic, AOC, and Reighhold Inc. Uses pieces, provides to contractor, then contractor provides the services	1 - midwestern US; supplies services to Canada and nationwide US 2 - well-acquainted/partnered with strong CIPP liner manufacturers including Applied Felts etc. 3 - Providers are condensed to northeastern area, thus services are likely constrained to that area (not as widespread across the US)	Wastewater, potable water, oil and gas	-	-	-
Interplastic Corporation	Chemical distributor	Polyester, vinyl ester	1 - Vinyl esters / polyesters are main primary focus for resin applications 2 - Wide capacity and application for resin (from marine ships, boats, spas and bathtubs, several applications and uses for their resin)	1 - Polyester resins, vinyl ester resins, gel coats, adhesives/compounds, and colorants 2 - Gravity pipeline resins, styrene-free CIPP resin, ONESTEP resins (single liq.	1 - Very large market and applications for company, many industrial sectors in which the resin can be used	Water, wastewater, oil and gas, etc..	-	-	-

				Initiator), UV cure systems, and pressure pipeline systems 3 - coatings available for large tanks etc.					
Lining Supply T3	Plumbing	Epoxy	1 - Provide 'superior trenchless products,' with an aim to connect with customers for confidence by providing trainings 2 - Expert help with application and use of products 24/7 3 - When equipment from T3 lining supply purchased, they provide trainings virtually, on the job, or in-house at one of their two offices 4 - One of the few companies that provide Trenchless Technical Training, customizable training as well	1 - A base resin with three choices of hardener 2 - various liners, application machines/materials, calibration tubes 3 - inversion systems/machines, rollers, coating systems, etc.	1 - Two offices in Springfield Missouri and Cerritos California 2 - product outreach is specifically to plumbing companies	-	-	-	-
Exxon Mobil Proxxima	Coatings, Infrastructure, oil and gas, wind	Grubbs Cat. And C5-monomer (polyolefin thermoset resin system)	1 - Claims similar to RapiCure but without the cost mentioned. Uses similar catalyst, but different monomer. 2 - Claims outperformance of typical polyDCPD, epoxy, vinyl ester, polyester. "Controlled fast cure," or "snap-cure" 3 - For oil and gas industry, "Reduce steel transportation cost, reduces energy costs, labor, and scrap... simpler, safer, and faster coating of pipes, joints, and equipment."	1 - Proxxima resin system (polyolefin thermoset resin, with Grubbs catalyst). Low viscosity, controllable fast cure. 2 - Exceed high performance polymers, Exxtra enhanced performance polymers, vistamaxx performance polymers, exact polyolefin elastomers (POE), ExxonMobil Core performance polymers, Exxtend technology, and much more	1 - Large and well-established company, spread nationally. Good connections with other companies 2 - Expansion opportunities globally 3 - Very well diversified in products offered and industry applications.	-	-	-	-
Impreg	CIPP Lining Manufacturing	Fiberglass and UV resins	1 - Strong focus in environmental sustainability - "Styrene free, preventative of resin migration," also claims to be energy efficient for materials and installation process.	1 - IMPREG liner GL16 - designed to overcome the most complex variables approached on a job site, such as weather, larger dimensions,	1 - Only one liner sold, thus all projections are based off single liner distribution. 2 - Could diversify products to bring in more revenue.	Water, wastewater, oil and gas?	-	-	-

			2 - Claims styrene free, but contains <4% mass styrene 3 - Provides 24-hour support, offers on-site support, trainings, or additional online support 4 - Very large emphasis on environmental social governance	changes in pipe dimension, different pipe materials (steel vs brick), etc. 2 - Liner DOES NOT NEED refrigeration!! But can only be stored for up to three months in ambient conditions 3 - Also sell/distribute liner accessories such as guide foils	3 - innovation for waterways / water to be protected and fixed.				
Spinello	Pipe repair and rehab services	unknown	1 - National, full-service contractors' provider 2 - Knowledge and expertise in CIPP application, provides well equipped personnel for job sites etc. 3 - Claims techniques etc. decreases costs, and trenchless approach decreases landscape repair cost	1 - Services range from geopolymer linings, CIPP linings, sliplinings, pipe bursting, lead service line replacement, CCTV and cleaning solutions for water/wastewater, bypass pumping solutions, and excavation for water and wastewater.	1 - primarily focused on sewer repairs, could expand into more varied fields of repair	-	-	-	-
SAK, sakon	Pipe repair and rehabilitation (mostly sewer)	polymer blend	1 - Owns pipenology, a CIPP liner manufacturer that directly provides for SAK. Also owns AffHolder, a pipe repair contracting business that sends the contractors out to repair sites. 2 - utilizes a polymer blend rather than a neat resin, also contains a cutting-edge sewing lab for liner construction 3 - ISO 9001 accredited pipenology lab for liner production 4 - emphasis on onsite safety when using products, evaluation situations for if they're safe, promotes a safety culture	1 - CIPP linings, Geopolymer solutions, spiral wound PVC (SPR) application that's environmentally friendly, and sliplinings. 2 - contractor services for pipeline and sewer repair	1 - lots of sewer rehabilitation projects, could diversify into other repair fields 2 - Robert Affholder, the cofounder of Affholder, served as vice chairman, and on the board of directors for 'Insituform (now aegion)	Water, wastewater, stormwater	-	-	-
Nexa Pipe	oil & gas, water, wastewater, mining,	1 - inner polymer liner (corrosion and	1 - Focus on innovation of the pipe-lining industry, and	1 - Versatile pipelining solutions ranging from 40mm to	1 - Positioned growth in Australia; currently moving	oil, gas, potable water,	-	-	-

	chemical processing, renewable energy	permeation) 2 - Fiberglass/carbon fiber reinforcement 3 - Outer polymer layer (environmental protection)	overcoming currently faced challenges centered around pressure rating issues and temp resistance 2 - Four primary valued propositions include pipeline safety, reliability, efficiency, and sustainability 3 - refers to their CIPP process as "flat tube technology," perhaps relining process is neither CIPP or SIPP? 4 - Emphasis in transitioning to New Energy-pipeline repurposing, energy innovation	1500mm in diameter 2 - Looking to diversify product by integrating smart sensors into pipe repair, developing more durable and environmentally safe materials, expanding into different pipe relining industries, and advancing installation techniques 3 - Advanced composite materials, state-of-the-art manufacturing processes, intelligent monitoring systems	towards a more global presence in industries such as oil and gas, mining, clean energy, water, and industrial fields. 2 - Advertising revolves around known facts about CIPP; "non-conductive" (so no lightning), saving money and energy with CIPP application, increases pipe lifetime, etc.	wastewater			
RestoLine	Manufacture of liners/resins and robotic spray lining systems. Chemical/refining, marine and offshore, industrial process and aviation, power generation and mining, public utilities, and midstream oil and gas	Epoxy, geopolymers	1 - Integration of new methods of pipe inspection, etc. integrating sensors into pipe liners for live leak detection and anomaly detection. Still also use a CCTV inspection as well, in addition to sensors 2 - Use of robotics for inspecting, cleaning, and spraying the internal liners. 3 - Robotic spray lining systems is what sets them apart from other companies. Use of robotics in addition to resin 4 - Class 1-IV type linings, differentiated products for different purposes 5 - Chemical and corrosion resistant coatings, resistant against aggressive gases 6 - Robotics utilize an Umbilical cord, using tow cables, tethers, etc. so a truck/car is necessary i think	1 - Internal and external coating systems for anti-corrosion/flow assurance solutions 2 - PipeGuard SLP (polymeric or epoxy priming systems) 3 - PipeGuard GP Series (geopolymer lining, exposure to high levels of H26 4 - PipeGuard SL5 rapid curing high elongation 5 - PipeGuard CL Series (mortar cement modified) 6 - PipeGuard SL6, TR series 7 - External coatings as well including PipeGuard E1L, E2L, and E3L 8 - Sensor array detection integrated into the pipe lining solutions	1 - Based in Singapore. Other locations include the Americas, Europe, Middle East, and Asia Pacific 2 - strong global presence, mostly throughout more Asian countries including Hong Kong, Malaysia, and Singapore. And US	oil & gas, water, wastewater	-	-	-
Fluid-7	Oil & Gas Pipeline Rehabilitation	Fluid membrane	1 - Using flid-7 technology prevents "fugitive methane	1 - Impermeable hydrocarbon fluid membrane	1 - Centralized in Australia 2 - Emphasis on	oil and gas, green energy	-	-	-

	, Decarbonization Services, Asset Lifecycle Extension, Repurpose or Green Energy	barrier technology	emissions required to manufacture new steel pipes 2 - Helps reduce CAPEX by up to 50% for new or replacement oil and gas pipelines 3 - Helps reduce OPEX up to 75% for maintenance and repurposing 4 - also focuses on repurposing to new energy pipelines, changing existing pipelines for new energy formats like hydrogen and ammonia 5 - claims operational efficiency by reducing operational costs by 75% with NO PIGGING, and installation time is reduced by 80%	solution - impermeable solution to solve fugitive methane emissions caused from aging infrastructure (leaks and pipe anomalies leaking methane out)	aging oil and gas pipelines, rehabilitating aging infrastructure and repurposing for new energy purposes for green energy 3 - Emphasis on fugitive methane emissions- methane that escapes from old pipes and contributes to the greenhouse gases-	chemicals such as ammonia and hydrogen, not green energy such as methane			
Savy & Sons	Water, wastewater, oil and gas, waterproofing, coatings/linings, infrastructure restoration	Polyurethane (waterproofing), epoxy (structural repair)	1 - Service-first approach to work, emphasis in customer service and aid 2 - contractor provider for relining work 3 - Saves money with trenchless solutions, technology allows for cleaning, descaling, and repairing all without disrupting the ground or nearby area (all trenchless) 4 - 24/7 emergency hotline for sewage backups	1 - CIPP repair service contractors (with necessary equipment and whatnot) 2 - Contractor services for inspections, both commercial and municipal homeowners etc. 3 - Epoxytec CPP spray liner	1 - primary location is in Connecticut 2 - Focused services in the Northeast US. Some work has been completed in other countries, but there is an opportunity to further expand 3 - Most featured work on their website include coating an linings service repairs	water, wastewater	-	-	-
Luna OptaSense	Pipeline, Power, Geophysical, traffic, and railway monitoring, oilfield service monitoring	Fiber-optic sensing	1 - global partner for fiber-optic sensing 2 - striving for operational excellence, especially in the health and safety realm. Implementation of greener solutions to minimize their carbon footprint. 3 - Pipeline monitoring technology; has capacity to detect leaks (+/- 10m accurate, detects	1 - Pipeline monitoring, oilfield services, power monitoring, geophysical monitoring, traffic monitoring, railway monitoring 2 - Oilfield services include seismic acquisition and processing, hydraulic fracture monitoring and	1 - locations spread out across the USA, UK, Germany, Canada, and the Middle East 2 - technology is only 'sensing' based, only products offered are sensing and monitoring options. Could diversify this technology by combining solutions, such as a pipeline monitoring	oil and gas	-	-	-

			0.1% leak size within minutes) 4 - Natural gas industry constantly seeking new techniques to monitor and address damage and intrusions, therefore this technology constantly is monitoring 5 - Committed to protection of valuable infrastructure assets, reducing the amount of resources and variables needed to conduct operations (increasing operational efficiency)	flow monitoring solutions. 3 - Inline inspection tool allows for both removing accumulated debris and assessing the condition of the pipes 4 - DAS; Distributed Acoustic Sensing technology	solution combined with a CIPP liner				

All references above are from corresponding company webpages.

Conclusions

RapiCure was able to identify the key materials used by SIPP/CIPP pipeliner manufacturers and service providers today. As shown in the materials column above, the key materials used include polyester, vinylester, polyurethane, epoxy, polyethylene, polyvinylchloride, and polyethylene or blends thereof. Epoxy was found to be the most widely used resin for CIPP. There were some examples of carbon fiber, glass fiber, or felt fabric incorporated solutions as well. One example of polyolefin thermoset resin is reported by Materia/Exxon, but without a quick curing capability. Several lining technologies and processes have been proposed in academic literature, but little to no commercially relevant information is available on those systems at this time, nor did we identify any quick-curing options. RapiCure also acknowledges that this is not a full comprehensive list of all CIPP/SAPL/SIPP or similar technologies and will continue to add to the table as new information becomes available. In conclusion, RapiCure intends to build from industry developments so far, and make every effort to integrate the quick-curing polyolefin thermoset resin offered by RapiCure as an improved solution for pipeline coating and lining.

[Item #4] [Task 10][Suggest improvements Q1] [Suggest improvements Q1]

We do not currently suggest any major improvements to the project scope; however, after various iterations, this deliverable has yielded the desired plans for eventual development of a tool that can extrude the liners for high-throughput manufacturing. The liners were developed mostly at 1’ and increased to 4’ liners. During development of the liners it was determined that the frontal polymerization process worked well for generating 4-foot liners when adding heat to just one end of the resin or waiting 30 minutes for the resin front to self-initiate and allowing the front to travel through the material to fully harden. During the pipeline liner fabrication, several modifications to the resin formulation were made to improve resin processing properties as well as mechanical properties of the obtained thermoset polymer. A total of nearly 6 kg of resin is required per foot of 1” thick liner. For future product development just 1/8” - 1/2" thickness of liner may be necessary to achieve the required strength required based upon PCC-2 guidelines. Several meetings were held, and results were shared and discussed with industry experts.

[Item #1/2] [Tasks 1&13][Team meetings and kick-off meeting] [Team meetings and kick-off meeting]
Various meetings were held either virtually or in-person with the relevant project stakeholders to discuss results, costs, and in-field processes. To this end several meetings with nearly all project team members were conducted (including at this stage several 1-on-1's).
The kick-off meeting was held on December 9th, 2024 with most TAP members and project affiliates in attendance including representatives from DOT-PHMSA. After the team member introductions, Dr. Heather Rubin from RapiCure Solutions presented the general framework of the project and got feedback from the team members. There will be monthly update meetings starting approximately in February/March-2025 on the last Thursday of the month lead by Dr. Ercan Bayram for delivering information to the project members and stakeholders moving forward, to ensure key stakeholder feedback is incorporated in the project scope based on results and stakeholder experiences.

[Item #6] [Task 3][Develop Coating Parts 1,2 and 3][Develop Coating Parts 1,2 and 3-1', 4' and optimized liners]

RapiCure completed the project deliverable 3 in Attachment #2. To this end RapiCure developed a quick-cure liner for pipelines using guidelines from the PCC-2-208 and ASTM F2207-06 at 12", 16" and 4' lengths. The internal team meetings (within RapiCure Solutions) were held weekly to discuss the progress of the project and strategize the best path forward for the project. Dr. Ercan Bayram and Dr. Heather Rubin also held regular one-on-one meetings to discuss the project deliverables and activities.

To cast the liners, initial trials were performed on smaller scale set ups. For pipe liners of 1' and longer with ca. 1" thickness, consumable tooling was integrated by way of cardboard tubes and/or galvanized steel pipes with different internal diameters (ID) ranging from 10" to 13". The tooling was eventually fixed to a tray, and heat was applied using various methods (optimized). Resin was poured into the tooling and cured by adding heat at one spot only, initiating frontal polymerization and generating a cured pipe within a pipe. After curing and fully cooling, the liner was removed from the tooling for further analysis.

The initial liners were exhibiting significant bubbling and yellowing, which could weaken the performance of the resultant liners. These challenges were addressed and significantly improved via an iterative process. The formulation was revisited, and the bubble formation was able to be eliminated yielding smoother liners.

The curing performance as well as the mechanical properties of the liners were also evaluated. The values demonstrated optimal curing performance along with mechanical properties that meet or exceed those of industry legacy materials. Although ASME-PCC-2 2018 (or ASME-PCC-2 2022) does not provide any minimum values for the required/desired ASTM tests for CIPP applications for the liners presented herein (other than strain to failure/elongation at break >1%), RapiCure Solutions set benchmark values for each test/measurable to obtain highest quality thermoset polymer possible after getting feedback from TAP and/or possible collaborators and customers as well as literature search for the thermoset polymers available in the market. The proposed ASTM tests (per ASME-PCC-2 2018) will be performed during the 3rd Quarter of the project and will be reported accordingly.

In conclusion, RapiCure successfully manufactured liners from 16” - 4’ and 1” thickness for 12” internal diameter pipelines. The liners were obtained via an iterative process that started with small prototypes and grew to larger liners and improved tooling. With only one spot of initiation, a 1-mile pipe liner/coating could cure as fast as 33 hours. Of course, multiple curing fronts will enable faster curing when needed. Next steps for the liners will include burst testing of the liners, and development of the proper equipment and plans to manufacture pipeliners that will allow for higher throughput manufacturing. Further testing may be completed in Q3 as planned for Material Characterization, Attachment #2, numbers 4 and 5. The final resin used herein may be further tuned during the next phases of development tasks.

[Item #5] [Task 14][1st Quarterly Status Report][1st Quarterly Status Report]

Careful discussion and considerations were made with discussions, milestone modifications, and reporting in Q1. All monthly reports were completed and emailed/updated. This 1st Quarterly Status report details the progress of the project and images of the liner development.

5: Project Schedule –

Project is on time in Q1, and ahead of schedule for planning of tasks 6 and 7.