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ABOUT YOU, YOUR COMPANY, AND YOUR EXPERTISE

- ME:
 - TECHNICAL BACKGROUND: APPLIED METALLURGY, MATERIALS SCIENCE, AND MANUFACTURING FOR POWER GENERATION, HIGH TEMPERATURE APPLICATIONS, AND ENGINEERING ALLOYS
 - CURRENT ROLE: SUPPORT STRATEGIC EPRI GENERATION ACTIVITIES INCLUDING LABS, MATERIALS, NDE, AND TECHNOLOGY INNOVATION
 - PAST ROLES: 10+YEARS EPRI (MANAGED MATERIALS & REPAIR PROGRAM, CROSS-SECTOR RESEARCH), US DOE A-USC CONSORTIUM TECHNICAL LEAD, 5+YEARS ORNL
- EPRI:
 - INDEPENDENT, NON-PROFIT, COLLABORATIVE R&D COMPANY FOR ELECTRIC POWER INDUSTRY
 - SCIENCE & TECHNOLOGY INNOVATION, THOUGHT LEADERSHIP, GLOBAL COLLABORATION
 - ALL ASPECTS OF ELECTRICITY: GENERATION, ENVIRONMENT, NUCLEAR, POWER DELIVERY, UTILIZATION

IMPORTANT WORK ALREADY UNDERWAY THAT WILL ENABLE THE SUITE OF ADVANCED MANUFACTURING APPROACHES FOR THE FUTURE OF CLEAN COAL AND CCUS TECHNOLOGIES

- ADVANCED POWER CYCLE SUPPLY CHAIN DEVELOPMENTS
 - A-USC CoMTEST
 - sCO₂ TEST FACILITIES
- LARGE NATIONAL CENTERS FOR MANUFACTURING (E.G. EERE'S MDF)

SEED IDEAS FOR DISCUSSION TODAY, HOW DOE CAN BETTER USE THE SUITE OF ADVANCED MANUFACTURING APPROACHES IN FUTURE CLEAN COAL AND CCUS EFFORTS

- BUILD END-USER CONFIDENCE, TWO SUGGESTIONS:
 - LARGE SCALE, COMPLICATED, COMPONENT/SUBSYSTEM TEST FACILITIES TO PROVIDE 'REAL-WORLD' EVALUATION OF ADVANCED MANUFACTURING TECHNIQUES
 - EXTRACT MAXIMUM VALUE IN LARGE SCALE DEMONSTRATIONS – BUILD IN ADVANCED MANUFACTURING TO STRESS SUPPLY CHAIN

REGARDING DEFINITIONS

“I BELIEVE THE USE OF ADVANCED MANUFACTURING IS THE APPROPRIATE TERMINOLOGY. AS SHOWN IN THE PRESENTATION BY THAR, THE COMBINATION OF TRADITIONAL PROCESSES AND ADVANCED PROCESSES TO CREATE COST-EFFECTIVE INNOVATIVE COMPONENTS/MATERIALS IS A NEAR-TERM REALITY AS OPPOSED TO FULL-SCALE 3-D PRINTING/ADDITIVE PROCESSING WHICH TODAY IS NOT GENERALLY COST EFFECTIVE FOR LARGE COMPONENTS”

“**CURRENT EXISTING** FOSSIL PLANTS MAY OFFER A GOOD OPPORTUNITY TO **TEST OUT NEW ADVANCED MANUFACTURING** TECHNOLOGIES AND ARE A **MORE LIKELY** TECH-TO-MARKET OPPORTUNITY COMPARED TO NEW COAL-PLANTS. “

THE CHALLENGE FOR ANY NEW MANUFACTURING ROUTE (NEW PROCESS, MATERIAL, OR AN INNOVATIVE DESIGN OF BESPOKE MATERIALS PROPERTIES IN AN INNOVATIVE DESIGN) WILL BE ACCEPTANCE. IN ORDER TO SPEED ACCEPTANCE, EPRI BELIEVES THERE ARE SOME KEY NEEDS:

- **LARGER-SCALE RELEVANT TESTING:** COULD BE COMPLEX FEATURE TESTING (LAB OR FIELD). SUCH TESTING PROVIDES:
 - INDUSTRY CONFIDENCE (SEEING LIFE-SIZE COMPONENTS IN ACTION)
 - VALIDATION DATA FOR MODELS SINCE YOU CAN'T TEST EVERYTHING (MOST MODELS ARE BASED ON SIMPLE DATA LIKE UNIAXIAL TESTS UNDER ISOTHERMAL CONDITIONS BUT REAL-WORLD COMPONENTS UNDERGO MULTIAXIAL FAILURE IN THERMAL CYCLING CONDITIONS)
- COST IS ALSO IMPORTANT, BUT COSTS CAN GO DOWN WITH TIME SO THIS SHOULDN'T NECESSARILY BE A CONSTRAINT, ESPECIALLY FOR REPAIR/REPLACEMENT/CURRENT PLANTS. IN TERMS OF CAPITAL COST, IT IS A KEY FACTOR FOR ANY NEW SYSTEM, NEW COAL PLANT, ETC., AND SHOULD BE MORE OF A FOCUS HERE.
- OPEN DATABASES OF MATERIALS PROPERTIES, ESPECIALLY WITH RESPECT TO ADDITIVE MANUFACTURING, WILL ALSO SPEED INDUSTRY ADOPTION. OPEN DATA:
 - AVOIDS **DUPLICATION OF EFFORTS**
 - BUILDS OVERALL CONFIDENCE IN MODEL INPUTS
 - GIVES THE RESEARCH COMMUNITY CLEAR GUIDANCE ON WHERE THE R&D NEEDS TO GO TO MAKE IMPROVEMENT AND INNOVATIONS IN THE FUTURE
 - SUPPORTS STANDARDIZATION (CODES, ETC.)

REGARDING CARBON CAPTURE AND STORAGE

THIS WAS ONLY TOUCHED UPON LIGHTLY IN THE VARIOUS TALKS DUE TO AUDIENCE MEMBERS, BUT EPRI SEES ADVANCE MANUFACTURING AS ONE OF THE NEXT BIG THINGS FOR CCS. TODAY'S CCS TECHNOLOGY HAS ADVANCED SIGNIFICANTLY BOTH IN TERMS OF THE CAPTURE PROCESS (EX: ADVANCED SOLVENTS) AND HEAT-INTEGRATION WITH THE POWERPLANT. HOWEVER, EVEN WITH THESE ADVANCEMENTS, THE TECHNOLOGY IS EXPENSIVE – ESPECIALLY CAPITAL COST

CAPITAL COST REDUCTION FOR CCS WILL BE AN IMPORTANT NEXT STEP WHICH ADV. MANF. CAN HELP WITH. IDEAS INCLUDE:

- IMPROVE HIGH-EFFICIENCY HEAT EXCHANGERS TO REDUCE OVERALL COMPONENT SIZES (AND HENCE CAPITAL COSTS FOR MATERIALS)
- IMPROVED MASS TRANSFER DEVICES TO REDUCE OVERALL COMPONENT/SYSTEM SIZED (AND HENCE CAPITAL COSTS)

“I AM NOT TOO FAMILIAR WITH ‘PROCESS INTENSIFICATION’ BUT FROM THE DESCRIPTION YESTERDAY, THE ABILITY TO DO PROCESS INTENSIFICATION FOR CCS THROUGH ADV. MANF. APPEARS TO BE APPROPRIATE IN THIS CONTEXT.”

REGARDING RESEARCH AND DEVELOPMENT

NON-DESTRUCTIVE EVALUATION (NDE): THIS WAS TOUCHED ON IN MANY SESSIONS AND IS IMPORTANT FOR A RANGE OF ITEMS:

- IN-SITU NDE TO MANAGE ADDITIVE MANUFACTURING PART QUALITY – THIS IS ALREADY BEING WORKED ON BY MANY PEOPLE TO IMPROVE THE QUALITY OF ADDITIVE PARTS AND ALSO PROVIDE NEW WAYS TO QUALIFY PARTS. THIS IS VERY IMPORTANT, BUT ITS GENERIC TO ADDITIVE AND IS ALREADY BEING RESEARCHED BY OTHERS.
- NDE OF COMPONENTS: TODAY'S FOSSIL PLANTS RELY HEAVILY ON INSPECTIONS TO MANAGE COMPONENT LIFE AND RISK. IN-SERVICE INSPECTION USING BOTH SURFACE AND VOLUMETRIC NDE IS VERY IMPORTANT. TO DATE, VERY LITTLE HAS BEEN DONE ON THE INSPECTION CAPABILITY FOR PARTS MADE USING ADVANCED MANUFACTURING, ESPECIALLY FOR FIELD APPLICATION OF NDE. THIS COULD BE A VERY CRITICAL AREA TO SUPPORT UTILITY ADOPTION OF NEW ADVANCED MATERIALS AND COMPONENTS. NEW STRUCTURES, MULTI-MATERIAL SYSTEMS, BESKOPE PROPERTIES, FUNCTIONALLY GRADED MATERIALS, AND COMPLEX PART GEOMETRIES ALL HAVE GREAT POTENTIAL TO IMPROVE PERFORMANCE, BUT ALL BRING IN-SERVICE INSPECTION CHALLENGES.
- MATERIALS NDE: A LONGER-RANGE BUT HIGH-POTENTIAL RESEARCH AREA IS ALSO NDE OF MATERIALS. THIS IS FUNDAMENTALLY DIFFERENT THAN TODAY'S IN-SERVICE INSPECTION, THIS IS THE USE OF NDE TECHNIQUES TO ASSESS MATERIALS PROPERTIES AND DAMAGE PRECURSORS. THIS TO OUR KNOWLEDGE HAS NOT BEEN LOOKED AT FOR ADVANCED MANUFACTURED PARTS, BUT MAY BE A WAY OF ASSESSING DEGRADATION OF COMPONENTS IN SERVICE AS THE FAILURE MODES FOR ADV. MANF. PARTS MAY BE DIFFERENT THAN WROUGHT OR CAST MONOLITHIC MATERIALS.

CODES & STANDARDS: THIS IS MORE THAN ASME ACCEPTANCE AND WE SHOULD ALWAYS REMEMBER C&S ARE A MINIMUM SET OF REQUIREMENTS, NOT THE ONLY REQUIREMENTS. COORDINATION WITH OTHER GROUPS LIKE NIST WILL BE NEEDED, ESPECIALLY SINCE QUALITY CONTROL FOR SOME ADV. PROCESSES IS FUNDAMENTALLY DIFFERENT THAN TODAY'S STANDARDS.

BULK THERMAL ENERGY STORAGE: A LOT OF TALK WAS PROVIDED ON FLEXIBILITY, BUT NOT MUCH THOUGHT WAS GIVEN TO THERMAL ENERGY STORAGE. IF ADV. MANF. COULD HELP REDUCE COST OR IMPROVE THE BULK THERMAL ENERGY STORAGE, THIS COULD BE ONE SOLUTION TO ELIMINATING A LOT OF DAMAGING CYCLIC OPERATION.

