2020 UNIVERSITY STUDENT DESIGN AND APPLIED SOLUTIONS COMPETITION (USDASC)

Overview

To realize its mission to equip society to protect people, assets, and the environment from the adverse effects of corrosion, NACE International embraces programs that will ensure that the future science and engineering workforce is actively engaged in understanding the impact of corrosion, how it can be mitigated, and how it can be prevented. The USDASC directly advances this mission.

The USDASC provides an opportunity to challenge advanced university students to use corrosion-related research and translate that into applied technology. Of equal benefit, university students will gain professional experience from this program as it challenges their engineering, business, presentation, and management skills.

The competition rules have been developed to allow teams to arrive at a design solution that optimizes each team's resources; permits teams to take different design approaches resulting in a wide variety of designs; and encourages students to compare their work against teams around the world. Succeeding in the competition will require a team to learn and apply the same skill sets needed to achieve success in any industry, military, or government sector, including research, design, manufacturing, testing, marketing, management, and finance.

As a result of participating in the USDASC, it is expected that participating students will:

- Gain practical experience by linking textbook theories to real-case scenarios
- Acquire and enhance project management skills
- Understand the pervasive impact of corrosion and methods used to prevent and detect it
- Gain insight into the field of corrosion science and engineering
- Increase exposure to corrosion-related industries for knowledge, as well as networking
- Gain insight into the types of assets and infrastructure worldwide that require corrosion control and prevention by experts in difference corrosion-related fields.

This competition requires the design of an applied solution that must be demonstrated. Although research is a component of the competition, it is not the sole focus.

Corrosion and the Role of Protective Coatings

Protective coatings are the most widely used method of corrosion control and account for approximately 90% of all expenditures for the prevention and control of corrosion. Coatings are

designed to be barriers that prevent or limit contact between a structure's surface and its corrosive environment. When a coating system is properly inspected and monitored, it can increase the useable life of a material (usually steel or concrete) while reducing replacement and maintenance costs.

All branches of the military as well as industry experience coating failures on structures such as weapons systems, vehicles, ships, aircraft, facilities, bridges, concrete, and pipelines especially in areas that are difficult to access. Inspection for corrosion, or pre-corrosion conditions such as coatings wear or degradation, is often a visual inspection. Some examples of these occluded spaces include box girders, in and around pipelines, and small spaces such as fuel tanks and aircraft fuselages. To exacerbate the issue, these areas are prone to collect moisture and accelerate corrosion.

All protective coatings systems must be monitored and inspected regularly and when necessary, remediation efforts must occur to prolong the life of the coating and protect the substrate.

2020 USDASC CHALLENGE TOPIC OVERVIEW

The challenge for the 2020 USDASC is to develop a system for corrosion inspection in difficult-to-access areas that can do the following:

- Inspect, identify, and quantify any corrosion-related defects found inside a fixed structure at the competition event in April 2020
- Move through the structure without human touch. System may be manually placed inside the structure and retrieved after inspection
- Communicate the information it discovers to an operator on its own team
- Succinctly report the location of the following items within 1 square inch:
    - Presence of surface corrosion, location, area and depth of corrosion penetration
    - Extent and type of coating degradation
- Teams must work within a budget which is included in the official rules

SYSTEMS

The teams will need to compile the findings of the system and report the findings to the judges in a paper report at the conclusion of the inspection. The format for this report will be supplied to each team.

- System cannot damage the structure in any way during inspection
- System should be able to inspect horizontal and vertical surfaces (and surfaces at angles in between). Multiple devices may be used.
- System should not be hindered by obstacles

COMPETITION & STRUCTURE

At the competition event, the system will be demonstrated on a fixed structure.

- Details of this structure such as the exact substrate material, coatings used, and its dimensions can be found on the event website (www.usdasc.com)
- The interior of this structure has been developed to represent any or all of the following:
    - Box girders, such as on bridges or frame rails of trucks
    - Highly structured areas: under antennas on ships, behind pipes, etc.
    - Small spaces such as pipelines, fuel tanks, and aircraft fuselage areas

2020 USDASC Official Competition Rules, Regulations, and Policies

Participants

This competition is open to undergraduates and graduate-level students currently enrolled at universities and military academies worldwide. Team members may be drawn from one single department or from several departments within a university or military academy. If multiple departments come together to comprise one team, more than one faculty advisor may work with the team.

Students must staff each team. Faculty advisors will certify that each member of the team is a student currently enrolled and attending courses at the university or military academy being represented. Contact information for each student must be provided and the USDASC reserves the right at any time to confirm that each student is currently enrolled and attending courses at the university or military academy being represented.

Team Size

Mandatory team representation includes:

- At least 1 faculty advisor
- At least 2 students (can be undergraduate or graduate, or any combination of the two for larger teams)
- There is no limit to the number of students participating; however, individual teams of 3-6 students are recommended.

Faculty advisors may be present during the competition but cannot in any way participate in the demonstration or presentation of results. One of the goals of this competition is for students to become more aware and knowledgeable of corrosion and its dangerous effects on assets. The competition encourages students to speak with and receive input from industry representatives however, all work must be completed by the students.

It is acceptable to have multiple students working on the project and only have a few represent the project at the final competition. The final list of students attending the final competition for each team will need to be sent to Dr. Ying Wang ywang@lsu.edu by February 14, 2020.

Registration

Registration will end on January 10, 2020. Each team will access the registration documents through the official competition website (www.usdasc.com). The registration forms are fillable PDF documents and can be downloaded from the website. Once the form is complete, please email it to Dr. Ying Wang ywang@lsu.edu by close of business January 10, 2020.

No late entries will be accepted and incomplete applications will not be considered. No responsibility can be accepted for entries not received for any reason. The competition will include a maximum of 12 teams. Once the registration application is approved, the team will be named as a participant. If the registration application is incomplete or the contest administrators have to contact the teams for clarification, a space will not be reserved for that team until the application is complete and approved.

A team's entry into the competition is deemed to be tantamount to that team's acceptance of the official rules and a confirmation that the entrants have the necessary authority to enter the competition.

The starting order of team demonstrations and presentations at the final competition will be based on the order in which teams register and submit an approved registration application. The starting order of team demonstrations and presentations will be published by March 1, 2020.

Teams must be present at the time(s) assigned and cannot shift the order in which the teams are to compete without approval from the competition administration. When the starting time has been set, each team must be ready at the competition site at the specific time designated.

If a team named as a participant in the competition does not attend the competition and does not compete without prior notification to the competition management, it may not be eligible to serve as an approved participant in subsequent design competitions administered by NACE International. The extent of this will be determined by the judges.

Host Site

The final competition will take place at Louisiana State University in Baton Rouge, LA. Details regarding the host site will be published and communicated to the competing teams.

Competition Date and Times

The competition is scheduled for Thursday, April 16 and will conclude Friday, April 17, 2020 at or near 5:00pm CST. Any changes will be communicated to participants via email.

Judging

A team of judges and contest officials will determine compliance with the rules. All rules must be followed and any deviations may result in disqualification or the deduction of points. Instances of disqualification or the deduction of points will be determined by the judges.

Additional items that can be grounds for disqualification, include:

- Intentional tampering with or interfering with another team's physical system or communication methods
- Deliberate damaging of the testing structure
- Actions designed to damage or destroy an opponent's system that are not in the spirit of the competition

The judges and contest officials reserve the right to refuse to award any points to a team who they decide (at their sole discretion) has violated these rules, gained an unfair advantage while participating in the competition, or won using fraudulent means.

Materials provided to each team at the close of Registration

Each team will be provided a steel panel that can be used for practice and to test for the presence of corrosion. This panel can be kept by each team and does not need to be returned at the conclusion of the competition.

Each steel panel will be pre-treated, and some corrosion defects will be included. Corrosion defects can include general corrosion, pitting, damaged coatings, and scratches. Students should be able to test for these types of damages. These defects may or may not be included on the final testing structure at the competition event.

The coatings used and surface cleanliness of the panels will be the same as used on the final competition testing structure.

Evaluation Criteria for Project

The evaluation criteria may be adjusted periodically. All changes will be communicated to the competing teams at the time of adjustment and posted on the event website (www.usdasc.com). Competing teams will be graded on the following items (each item is explained in greater detail below):

Written Report – 20% of total score
Due Date: Wednesday, April 1, 2020
To earn points, the report must be received either via e-mail or delivered by this date. Send to:
Kim Ray
NACE International
15835 Park Ten Place
Houston, TX 77084
Kim.ray@nace.org
281-228-6256

The written report should contain information pertinent to the approach the team took to complete the project and design a solution. Items to consider for inclusion include:

- Information that addresses why this solution is needed, the proposed solution/approach, the requirements and constraints of the proposed solution, detail on methodology in design development, how was the problem broken down into needs and requirements, a time table associated with the project, the success criteria used to determine the solution, the budget, and an identification of any appropriate coatings standards used.
- Design Elements such as drawings, circuit diagrams, program code, bills of materials, operating instructions, etc. It should include everything required to replicate the construction and operation as well as overall approach to design. etc.

Evaluation Criteria will include items, such as (200 potential points):

- continuity, clarity, and organization of the documentation presented
- quality of research presented
- innovation in design of proposed solution
- methodology used by the team to create the final applied solution and the testing methods applied
- replicability of the solution (students should consider factors such as the cost associated with reproducing the solution presented);
- materials required to build the system
- advantages of proposed solution
- applicability to the competition design challenge topic

Each team must present a budget of all expenses associated with the design and build of its system. The final cost of the all components used on the system should not exceed $5,000. Points may be deducted if expenses exceed this amount. Funding of each team's system is not provided by the competition.

If a team uses a donated or borrowed item in its system design or rents an item, the full fair market value of that item must be configured into the final cost for the system.

The report cannot exceed 75 pages in length. It can be formatted in any manner that the team prefers with regard to font, margin size, etc.

Oral Report – 10% of total score
Presentation of design and system overview at competition event to the judging panel.

The oral report should include any adjustments made to the system since the written report was submitted and should be considered a final report of the system design to the judges. Any slide presentations used in the oral presentation must be emailed to Dr. Ying Wang ywang@lsu.edu or posted on a shared website (with instructions for accessing the presentation emailed to Dr. Ying Wang ywang@lsu.edu) by Wednesday, April 15, 2020. Presentations submitted after 7:00pm CST will not be accepted.

Evaluation Criteria will include items, such as (100 potential points):

- continuity and clarity of presentation / report
- presentation skills
- presentation design
- professionalism
- participation by each team member
- overall impression

Each team will be given an allotment of 20 minutes for its presentation to the judging panel. Each student in attendance should present a portion of the project plan during this time allotment. Time will be allowed afterwards for questions. Teams will not be penalized for not using all allotted time if all items are well addressed.

Teams are encouraged to attend the presentations of the other competing teams. By attending other presentations, teams can learn from other team's presentations and methodologies.

Demonstration of applied solution on fixed at final competition – 70% of total score
The specific design and size of the fixed structure used in the final competition is included at the conclusion of these rules. Each team should be prepared to demonstrate its solutions on this structure. Each team will be using the same setup and cannot modify the structure in any way during competition.

The final competition will take place indoors and there will be no underwater testing.

Project Technical Outcome
Each team will be required to provide the exact location of any areas of corrosion it locates, determine the extent of the damage caused by corrosion, locate and determine areas of coating degradation or damage, and report its findings to an operator (on its own team) that can provide this information to the judging panel. Teams can only use non-destructive testing methods on the

coatings they find on the final testing structure. Destructive testing cannot be used, and any use of such methods may result in team disqualification.

The system can be controlled and maneuvered inside the fixed structure using any means other than human touch. It is not required to be wireless and can include cables. There are no limitations with regard to the size and length of any cable. After manually placing the system inside the structure at the beginning of the inspection, all team members and advisors will be required to stand behind a line approximately 10' away from the structure during the remainder of the inspection until the system is retrieved at the conclusion of it. All team members and advisors will have visual access to the outside of the structure.

If any team advisors would like pictures or video of the system inside the fixed structure, the competition administration will obtain it for them.

The judging panel will be considering the following during grading:

- Identification and Reporting of each instance of corrosion (point range 0 – 250)
    - Using the criteria below, the system must identify and correctly report the following back to the operator and be recorded on a control sheet (format will be provided – it will be an Excel document) that allows the judges to easily determine its accuracy:
        - The specific type and location within 1 square inch, size and depth of each instance of surface corrosion
        - The specific type and location and extent within 1 square inch of each instance of coating degradation

    For each type of defect, the ability to characterize different aspects of the defect are important.

Defect Type	Increasing Difficulty in Detection/Measurement Accuracy →		
	Minimum	Better	Ideal
Corrosion	• Identify existence and type of corrosion at that location • Appearance/photo of corrosion	• Pit diameter of 3mm (~1/8in) or greater • Corrosion depth of 3mm (~1/8in) or greater	• Pit diameter of 1mm (3/64in) or less • Corrosion depth of 1mm (3/64in) or less

Identification of the presence, type, and location within the test piece of any corrosion should be considered the minimum criteria. The ability to measure/estimate the size and depth of the corroded areas would be an important improvement to be able to accomplish beyond detecting, identifying and locating the areas. In addition to general corrosion, corrosion may also take on the form of small pits. Detecting any pits, identifying their location, and being able to size the pit diameter and pit depth for diameters and depths larger than 1/8" also marks an improvement in corrosion detection ability. Because pits can be much smaller in diameter and depth than 1/8", locating and being able to measure diameters and depths that are smaller than ~3/64" (1mm) would provide a significant improvement in capability compared to detecting corrosion. Detecting depths of areas of general corrosion of less than 1mm (~3/64 in) is an improvement over simply detecting the

presence of general corrosion, and detecting depths of areas less than 3mm (~1/8 in) is a significant improvement over simply detecting the presence of general corrosion.

Defect Type	Increasing Difficulty in Detection/Measurement Accuracy →		
	Minimum	Better	Ideal
Coating Damage	• Missing, damaged, or blistered coating (size)	• Coating damage greater than 6mm (1/4in) diameter • Scratches greater than 50mm (2in) long in coating	• Coating Holidays less than 3mm (~1/8in) diameter • Scribe creep and corrosion in scratches

Detecting coating damage in the test structure should be considered the minimum ability criteria. Coating damage can range in size from gross coating loss to scratches to small pinholes, and can include blistering. Detecting, locating, and identifying the appearance of any coating damage should be considered a basic capability. Providing the actual dimensions of the coating damaged areas is important. Detecting, locating and sizing of blisters and defects such as scratches that are 2in long and pinholes (holidays) that are ¼in diameter would be considered an improvement in capabilities compared to the minimum criteria. The ability to detect, locate, and size scratches that have scribe creep and pinholes that are less than 1/8in diameter would be a further improvement in capability. Scribe creep is the term used to define the corrosion underneath coatings and loss of coating adhesion in areas immediately adjacent to coating scratches.

- Accuracy for locating corrosion and water presence over the entire structure (point range 0 - 250)
    - Using the criteria below, what is the percentage of the representative structure that the system CORRECTLY inspected for corrosion?
        - 0 – 20% will earn 15 points
        - 21 – 40% will earn 35 points
        - 41 – 60% will earn 60 points
        - 61 – 80% will earn 90 points
        - 81 – 90% will earn 175 points
        - 91 – 100% will earn 250 points

- Movement and Control of the System (point range 0-200 points)
    - The system will be grading on performance in these instances:
        - Negotiation of obstacles
        - Ability to inspect all surface areas required
    - If the system becomes unable to maneuver and a team member needs to assist the device to continue, a standard deduction of 75 points per instance will be applied to the score.

- Compliance
    - Points will be deducted for each instance of non-compliance with the official rules of the competition, and the number of points deducted will be at the discretion of the judges
    - If the system damages the structure in any manner, points will be deducted at the discretion of the judges

The structure should not be damaged in any way during team demonstrations. All materials are required to be removed before the 45 minutes allocated for the inspection have expired. Points may be deducted for items left in the structure or any damage to the structure inflicted during a team demonstration. The structure will be inspected for such instances between competitors.

Reporting of final results to the judges

Teams will be given a 60 minute allotment of time to complete the inspection and compile its findings and generate its report for the judges. This time allotment will include team set up at the structure, inspection of it, and retrieval of the system from the structure as well as the time to tabulate its findings. Each team may use this 60 minutes as it chooses but the inspection must not exceed 45 minutes. For example, if a team completes its inspection in 25 minutes, it may use up to 35 minutes to tabulate its results.

Each team will use the same standard form for reporting its results to the judges at the conclusion of the inspection. This will be a standard Excel form on which each team will note the exact location, size, and depth (if applicable) of each instance of corrosion and coating defects it detects. The form will be given to each team at the final competition on a flash drive. Teams may enter its data and include any photographs of the corrosion it finds. This must be completed and remitted to the judges at the conclusion of the 60 minute time allotment. It will be very specific and each team must use this form to report its findings. It will be compared to a judges' key to determine the accuracy of the data presented. Methods of gathering the information will not be evaluated during the demonstration portion of the competition. Please note that laptop presentations of the findings will not be accepted.

Because of this requirement, each team is strongly encouraged to use the written and/or oral reports to explain and accentuate its method for detection, how the information was used to report the results, and highlight its innovation and originality.

The winners of the competition will be determined by the highest score assigned of all three elements of the competition (written report, oral report, and demonstration). In case of a tie, the judges will confer to determine the winner and consider items such as the amount of time the system used to detect corrosion on the competition structure and overall performance. Winners will be named for first place, second place and third place.

Sportsmanship

All students participating are presumed to be responsible individuals and will be treated as such. Students, faculty members, and each university or military academy are responsible for any liability arising from their conduct while at the competition, or while traveling to or from the event.

General Information

Contest administrators are not responsible for any expenses incurred by entrants in connection with participation in the contest.

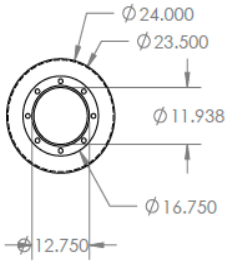
The official rules may be revised at any time, and participants are encouraged to review the rules posted on the competition website with regularity. The contest administrators reserve the right to cancel or amend the competition and these terms and conditions without notice in the event of catastrophe, war, civil or military disturbance, act of God or any actual or anticipated breach of any applicable law or regulation, or any other event outside of the contest administrator's control. Any change to the competition will be communicated to the entrants as soon as possible by the contest administration.

The contest administrator's decision in respect to all matters to do with this competition will be final and no correspondence will be entertained with regard to the final decisions.

By participating, entrants grant the USDASC exclusive permission to use their names, characters, photographs, videos, voices and likeness in connection with the competition and for future promotion and marketing purposes and waive any claims to royalty, right, or remuneration for such use.

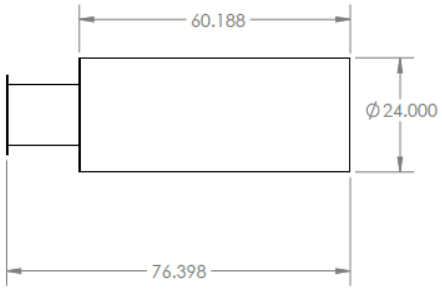
Any question regarding the competition or the official rules may be sent to Dr. Ying Wang ywang@lsu.edu.

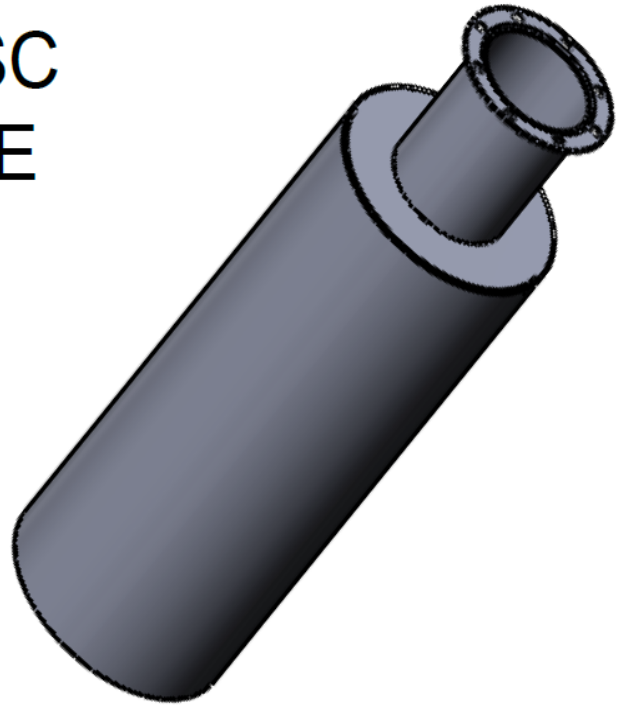
Perspective from the top of
the pipe with the smaller diameter (B1)

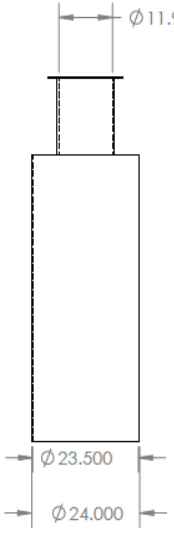


2019 USDASC CHALLENGE

University Student Design and Applied Solutions
Competition Fixed Final Competition Structure







General Information:

The pipe will lie flat for the competition and the systems you design will enter from the larger 24" diameter opening and navigate through the pipe without the aid of human touch to location specific instances of corrosion and/or coating defects and report its findings back to an operator on your team.

The pipe location will be fixed and it will be restricted from rolling.
The pipe will rest on the floor of the host site for the competition.

The interior of the pipe will be coated. Specific instances of corrosion and coating defects will be introduced into the pipe for the systems to locate and identify.

The exterior of the pipe will not be included in the competition inspection.

This is a new testing structure - questions for clarification of any kind are welcomed. Please email kim.ray@nace.org. All questions and answers will be posted on the event website under the Q&A tab.

Materials to be used to build structure:

A36 STEEL

Primer:68HSrichzincepoxyprimer
Coating:PSX700
Thickness of steel: 1/4"

See MSDS and Product Safety Sheets provided on www.usdasc.com

All dimensions are in inches

Obstacles that could be included in the structure (maximum height of any obstacle will be 3 inches):

- Box Channels
- U Channels
- S Channels
- Bolt fasteners
- Lap joints
- Welded joints
- Adhesive bonded joints
- Dissimilar metal joints
- Rib and gusset reinforcements