

# Thermal Spray Operator Certification

## ITSA Annual Meeting - Charlotte, NC

May 19-21, 2011

Presented by:  
**Dr. Aaron Hall**  
**Sandia National Laboratories\***  
**Chair TSCC**

\*Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

# Working Together for CTSO



GE  
Aviation



**Rolls-Royce**



**CONSTRUCTION**

**Polymet**



**SULZER**

Sulzer Metco

GE Energy



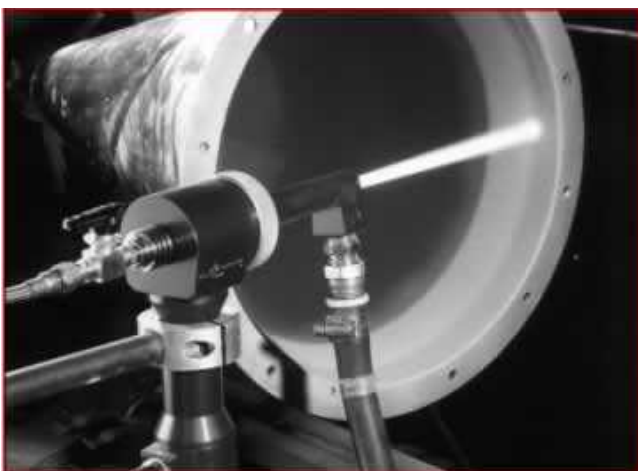
The Tucker Group LLC



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# Thermal Spray Certification Committee (TSCC)



Also supporting the TSCC:  
**Charlie Kay** (TSS President) &  
**Dr. Mark Smith** (ASM Board Liaison)  
**Dr. Ann Bolcavage** (TSS Board Liaison)

Member	Company
Aaron Hall (Chair)	Sandia National Labs
Bill Lenling (Vice Chair)	TST Coatings
Michael Canada	The Canada Group
Chris Dambra	Sulzer Metco
Marc Froning	BASF
John Hayden	Hayden Corporation
Rick Hayden	Hazelett Strip Casting
George Kim	Perpetual Technologies
Kris Kitchen	Nooter Construction Co.
David Lee	Deloro Stellite
Mark McCoy	Praxair
John Nerz	GE Aviation
John Passmore	St. Louis Metallizing
Luc Pouliot (Fmr. Chair)	Tecnar
David Somerville	SouthWest United Ind,
Bob Unger	Polymet
Matthew Ward	GE Energy
Anirudha Vaidya	Siemens
Kent VanEvery	Progressive Surface
Wilson Wong	Graduate Student, McGill University



# This is Your CTSO

- Industry driven
- Built by members of the thermal spray community
- Based on needs of technology providers AND users



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# Certification is Valuable

- In the words of Dr. Malcolm Thomas (Rolls Royce, IAC)

“In any operator dependent activity such as NDT, welding, thermal spray, engine repair etc., there are many advantages to all if there is an independent body that certifies a basic level of understanding and competence. It is not in anyone’s interest for the OEM’s to create this independently.

Not only will it give the end users confidence in the product, but it will enhance the status of thermal spray.”



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# Milestones/Objectives for 2010

- To administer the Grandfathering Program
  - Completed June 2010
- To develop test items for written practical exams
  - Published December 2010
- To develop requirements for practical exams
  - Specific exam details in process
- To beta test the General Knowledge exam
  - Went live on 11/11/10
- To continue gathering support from Thermal Spray Community
- To continue reporting progress to ASM-TSS Board and to You

**WE DID ALL THAT AND MORE...**



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# 3-Steps to CTSO



Step 1: General knowledge  
written exam (c. 100 questions)

Step 2: Specific process written  
exam (c. 40 questions)

Arrange to take test at  
Kryterion site

Step 3: Actual performance in  
process

Provide a coupon to TSCC  
requirements for acceptance  
testing at third party lab



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# CTSO Registration is easy through the TSS website.

	Grandfathering Applications no longer accepted	Pilot Program Applications no longer accepted	CTSO Program
<b>Part 1</b> General Knowledge Exam (written)	Waived	Included	Included
<b>Part 2</b> Performance Exam (written)	Waived	Included*	Included*
<b>Part 3</b> Performance Exam (hands-on)	Included**	Included*	Included *
<b>Total Price</b>	<b>\$350 member/ \$465 nonmember</b>	<b>\$500 TSS member/ \$645 nonmember</b>	<b>\$700 TSS member/ \$845 nonmember</b>
<b>Additional Performance Tests</b>	<b>\$250 Each</b> (Includes Only Part 3, hands-on)	<b>\$350 Each</b> (Includes Part 2 & Part 3 )	<b>\$450 Each</b> (Includes Part 2 & Part 3)
<b>Retaking Exams ( for all participants ) Part 1: General Knowledge Exam - \$200</b> <b>Part 2: Performance Exam - \$100 Part 3: Performance exam - \$350</b>			
<b>Recertification:</b> <b>First 3 years</b> – By points or full re-examination - \$295 <b>After 6 years</b> – Successful completion of Part 3 Performance Exam (per method) – at \$350/method <b>Every 3 years thereafter</b> – alternate requirements for years 3 and 6			
* Additional \$60 surcharge for non-N. American applicants ** Grandfathering pricing includes Part 3 Performance exam; Parts 1 and 2 are waived. *** Pricing includes one written performance exam and one hands-on performance exam. Pricing as of 7/15/2010; pricing subject to change			

**TSS<sup>SM</sup>**  
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**Certification**  
CTSO Qualifications  
CTSO Program Overview  
Application  
Testing Instructions  
Recertification  
Participating Organizations  
Benefits  
FAQs  
Committee  
Contact Us

**Certified Thermal Spray Operator Program (CTSO)**

**Certified Thermal Spray Operator Program**

**CTSO Program**

The ASM Thermal Spray Society has developed a certification program for the thermal spray community to recognize the quality of skills in the industry and enhance the value of certified Thermal Spray Operators.

Qualified thermal spray operators have the opportunity to prove they have achieved an industry wide qualification standard.

Click [here](#) for full details and to learn how to participate

Dr. Malcolm Thomas, Rolls-Royce Fellow and chief of Design Systems Engineering, summed up the need for the CTSO Program:

"In any operator-dependent activity such as thermal spray, NDT, welding, engine repair, etc., there are many advantages for everyone involved if an independent body certifies a basic level of understanding and competence. It is not in anyone's interest for the OEMs to create this independently. Not only will it give the end-users confidence in the product, but it will enhance the status of thermal spray. I do not underestimate the difficulties here, but I think the prize is substantial, and it is simply the right thing to do."

The Thermal Spray Certification process consists of three parts:

- PART 1 - Written Exam**  
General Knowledge of Thermal Spray Fundamentals
- PART 2 - Written Exam**  
Specific Process Knowledge: Wire Arc, HVOF, Air Plasma, Flame Spray, Cold Spray.
- PART 3 - Hands-on Performance test**  
Specific Process: Wire Arc, HVOF, Air Plasma, Flame Spray, Cold Spray.

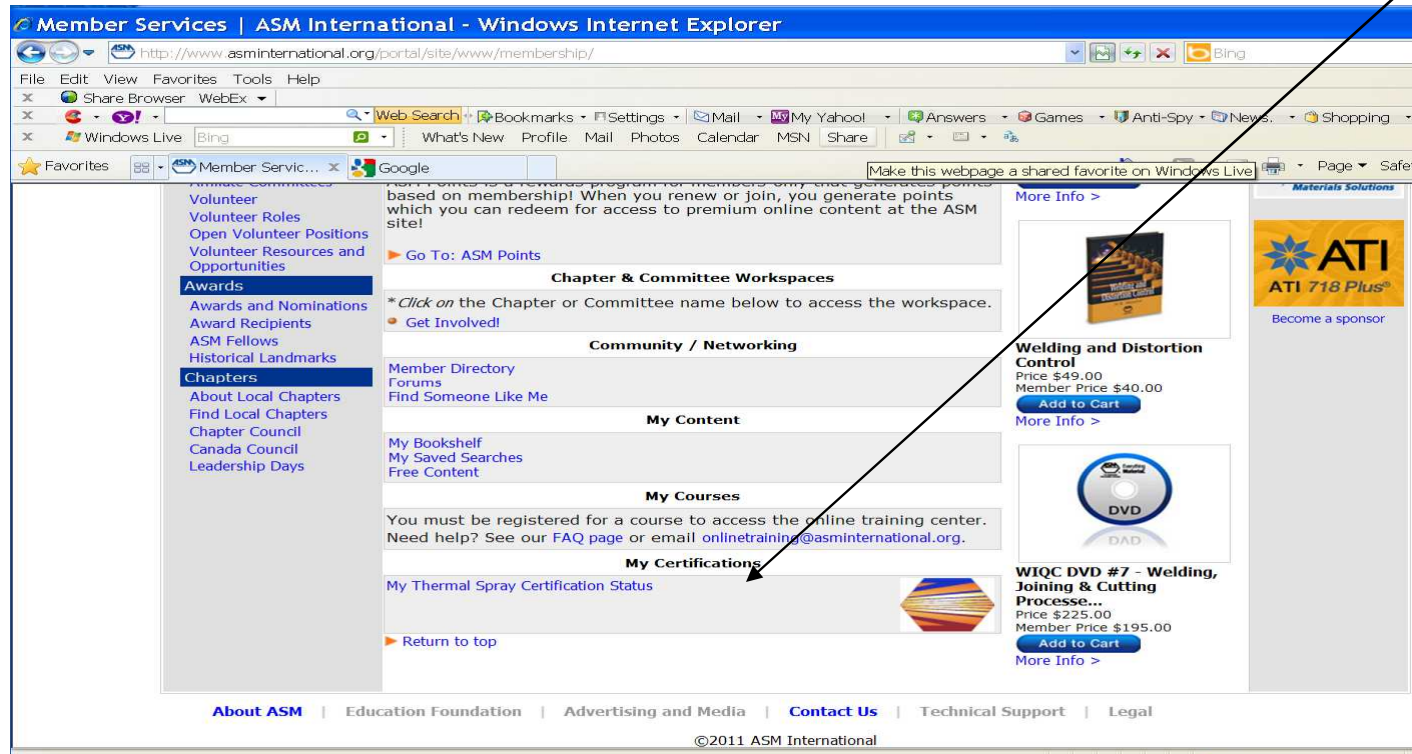
This program was developed with full support and cooperation of manufacturers and suppliers as well as the ASM Thermal Spray Society. The ASM Thermal Spray Society is the foremost organization for the operator, engineer or researcher and is an established society providing resources to the greater thermal spray community.

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# Testing process

- Single sign on through ASM website



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# CTSO candidate home page

CTSO  
CERTIFIED THERMAL  
SPRAY OPERATOR

TSS<sup>SM</sup>  
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Logged in: Liz Carpenter  
SHOPPING CART | HELP

CONTACT USHOMEREGISTER FOR AN EXAMINATION

## Home

### Exam Schedule

Hello Liz Carpenter!

ASM's certification examinations are available at hundreds of testing centers around the world. You can take you test at a Kryterion High-stake Online Secure Testing (HOST) Location. To find out more about ASM's Certification exams, please click [here](#).

#### SCHEDULED EXAMINATIONS

Examinations	Date Scheduled (mm/dd/yyyy)	Date Registered (mm/dd/yyyy)	Details
None found.			
<a href="#">Schedule an Examination</a>			
<a href="#">Email me my Scheduled Examinations</a>			

#### IN-PROGRESS EXAMINATIONS

Examinations	Date Scheduled (mm/dd/yyyy)	Date Registered (mm/dd/yyyy)	Date Launched (mm/dd/yyyy)
None found.			

#### COMPLETED EXAMINATIONS

Examinations	Date Launched (mm/dd/yyyy)	Date Completed (mm/dd/yyyy)	Result
None found.			

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# Sample question

Item Bank Management - Windows Internet Explorer

https://www.webassessor.com/form/editQuestion.do

File Edit View Favorites Tools Help

Favorites Suggested Sites Get More Add-ons CareerTech Testing Center CareerTech Testing Center Free Hotmail IUMRS Wikispaces - ElWehrle - My

Item Bank Management

## Webassessor™

### Item Preview

1. Really really fake Item just for example

- A. ☐ 1 two dozen eggs
- B. ☐ 2 fourteen Chevy Camaros
- C. ☐ 3 eight hotels on Park Place
- D. ☐ 4 five golden rings

Cancel Submit

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Done Internet 100%



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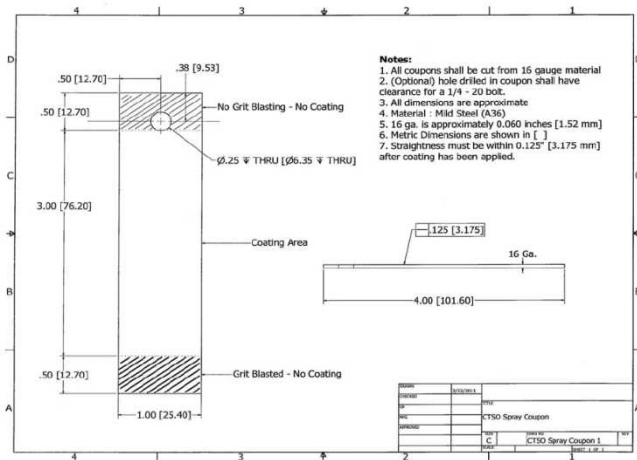
# Pilot testing program 2010-11

- **General Knowledge exam completed 11/11/10**
- **All five written process exams completed 12/23/10**
- **Passing scores set March, 2011**
  - Workshop lead by test development expert
  - Criterion referenced examinations
  - Gen. Knowledge = **72%**, 5 Process Exams = **76%**
- **All written tests administered at test vendor sites**
  - Kryterion is test vendor – [www.kryteriononline.com](http://www.kryteriononline.com)
  - Hundreds of test sites throughout world
  - Candidates choose their test site and test time
  - Avoids overnight travel to remote site
  - Avoids arranging to have test proctor on site



# CTSO Practical Exams

**Figure 1. CTSO WIRE ARC SPRAY Practical Exam Coupon**



- Wire Arc Spray
- Flame Spray
- Air Plasma Spray
- Cold Spray
- HVOF

- Developed to be cost effective
  - Candidate receives TSCC requirements
  - Candidate uses own workspace/tools
  - Candidate sends coupon for testing
- Tests operator ability to prepare a coating
- Working with third party test lab – IMR Test Labs
- Created according to standards
  - ISO 14918
  - MIL STD 2138
  - MIL STD 1687
  - MIL STD 3021
  - AWS C16.2

# Milestones/Objectives for 2011



- Study materials developed by Education Committee
  - Lead by Daryl Crawmer
  - Study course to help candidates prepare for CTSO exams
    - Online, self study component
    - Instructor led training
    - Follows outline of Job/Task Analysis
  - Additional study materials
    - Thermal spray blogs
    - Thermal spray content
    - Free safety downloads from TSS website
- Publish a Guide to the Thermal Spray Body of Knowledge (TS-BOK)



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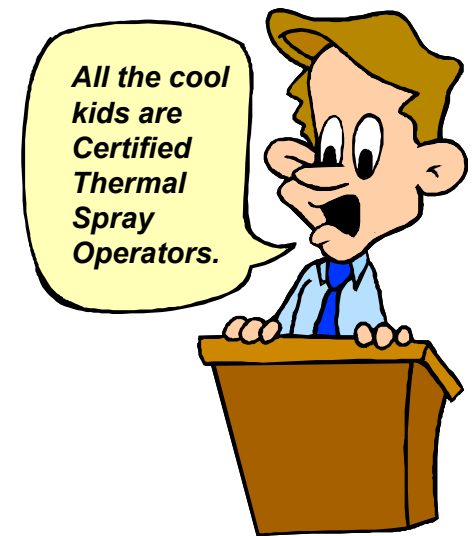
# Milestones/Objectives for 2011

## – Webinars:

- Short information sessions about topics of interest to thermal spray

## – Sample topics:

- Safety/OSHA regulations
- New equipment/processes
- Standards & regulations
- Quality control



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# Milestones/Objectives for 2011



- Increase recognition of CTSO
  - Companies with CTSO employees
    - May be listed on CTSO website
    - Can use CTSO logo on their site
    - May include information on RFPs
- Administer the CTSO Exam Program
- Improve the CSTO exam and expand the question bank
- Continue gathering support for CTSO from the Thermal Spray Community
- Report progress to ASM-TSS Boards and to You



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# Here's our new logo – note the TM



- ASM is pursuing copyright protection for the CTSO exams as appropriate.

# CTSO Practical Exam Data

- ASM will be collecting detailed process data through the CTSO practical exam:
  - Surface preparation
  - Torch configuration
  - Process operating conditions
  - Coating microstructure and properties
- *The CTSO practical exam will become the largest round robin experiment ever conducted in the thermal spray community.*



Table 3 CTSO WIRE ARC SPRAY Practical Exam Coating Data Sheet

I. Submit original with coupons to IMR  
II. Submit one copy of document to ASM  
If category not applicable, mark as N/A

<b>Substrate</b>	
Material	
Source	
<b>Feed Stock</b>	
Wire composition	
Wire manufacturer	
Wire name and part number	
Wire Diameter	
<b>Masking</b>	
Original surface: masking material type	
Grit blasted surface: masking material type	
<b>Surface preparation</b>	
Grit type and size	
Blasting pressure, psi (kPa)	
Blasting type (i.e., suction, pressure)	
Blasting nozzle to work distance, in (mm)	
Blasting nozzle to work angle, degrees	
Blasting rate, Ft <sup>3</sup> /hr (m <sup>3</sup> /hr) – if applicable	
<b>Spray equipment</b>	
Torch Make and model	
Torch nozzle type and size	
Torch Air cap type	
Power supply – if applicable	
Arc control unit	
Other equipment parameters	
<b>Spray parameters</b>	
Amperage, (A)	
Voltage, (V)	
Atomizing gas type:	
Atomizing gas pressure, psi (kPa)	
Gun to substrate distance, in (mm)	
Gun to substrate angle, degrees	
Substrate temperature (°C) immediately after spraying	
Gun traverse rate, in/min (mm/min)	
Minimum coating thickness/pass, (mm)	
Maximum coating thickness/pass, (mm)	
<b>Final coating thickness (minimum of 5 measurements)</b>	
Minimum, (mm)	
Maximum, (mm)	
<b>Other/Remarks</b>	



- What should we do with the data?

# Boundaries for CTSO Data

- ASM will never release CTSO data without written permission.
- ASM will never associate candidate or company names with CTSO data.

## Supervisory Data Permission

ASM is discussing publishing data from the CTSO practical exams in a form that is usable by the thermal spray community. The data will be published with no identification of the candidate or the candidate's employer. It is anticipated that these aggregated data points will contribute further to the understanding of the thermal spray process. ASM seeks your permission to publish aggregated data from your practical examination.

Please check the option you choose for data collation and sign below.

- ☐ Permission is granted to publish all data anonymously for the purpose of enhancing the understanding and use of the thermal spray process.
- ☐ Permission is granted to publish ONLY the micrographs and mechanical properties data anonymously for the purpose of enhancing the understanding and use of the thermal spray process.
- ☐ Permission is refused to publish any data for any purpose whatsoever.

Signature \_\_\_\_\_ Date \_\_\_\_\_

Position/Job Title \_\_\_\_\_



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# Summary



- We believe that certification will significantly contribute to our shared objective of expanding TS markets and improving coating quality
- A more involved workforce will help us advance as an industry
- Enhanced reliability & consistency will lead to enhanced reputation of our industry
- We need YOUR continuing support

***As the saying goes: “TOGETHER, WE ACHIEVE MORE”***



# Working Together...

Feel free to contact us at any time!



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# Questions are Welcome!



*Thank you so much for your Time & Attention*