



2023 Spring Conference at Rocky Gap Resort
Flintstone, Maryland
County Standardization of Manhole Frames and Covers

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1

BIOGRAPHY

- Region Sales Engineer with Neenah Enterprises
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2

ABSTRACT

County Standardization of Manhole Frames and Covers

1. how cast gray and ductile iron infrastructure castings are manufactured, including basic processes and manufacturing limitations
2. the most common materials and properties of materials that are used to produce gray and ductile iron infrastructure castings
3. the different load ratings that infrastructure castings are designed to withstand
4. basic tools that will allow them to better select cast gray and ductile iron products for infrastructure projects
5. standardization of manholes and the process to go through to make this happen

- 1.0 PDH

3

Table of Contents

- Basic Casting and Foundry Principles
- Cast Gray and Ductile Iron Material Properties
- Casting Load Rating
- Summary of Selection Criteria for Infrastructure Castings
- Standardization of County Manhole Frames and Covers

4

4

Basic Casting and Foundry Principles

- **What is a casting?**

- An object made by pouring molten metal (or other material) into a mold.



5

5

Basic Casting and Foundry Principles

- **4 Types of Casting Processes**

1. Lost Foam
2. Permanent Mold and Die Cast
3. Centrifugal Casting
4. **Sand Casting**

- **Green Sand**



6

6

Basic Casting and Foundry Principles

- How are Infrastructure Castings Made?



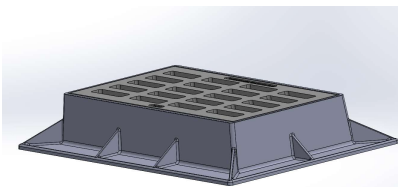
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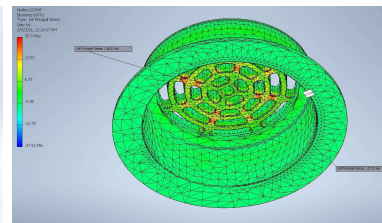
Basic Casting and Foundry Principles

- Casting Design

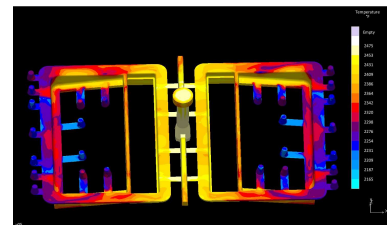
- Conform with Federal, State, Local or customer specifications
- Software used:
 - 3D Modeling
 - Finite Element Analysis
 - Computational Fluid Dynamics



3D Model of Infrastructure Product



Finite Element Analysis



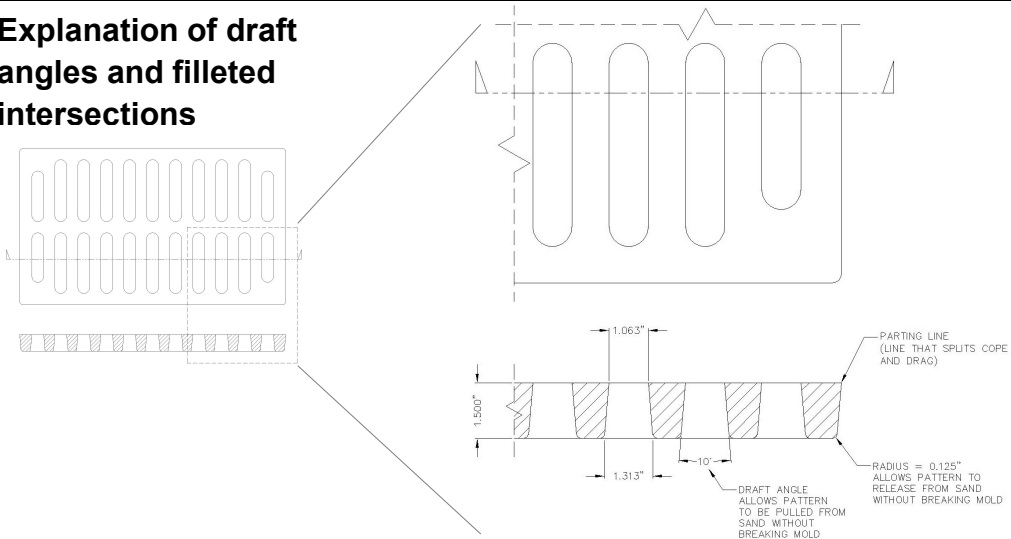
Computational Fluid Dynamics Software

8

8

Basic Casting and Foundry Principles

- Explanation of draft angles and filleted intersections



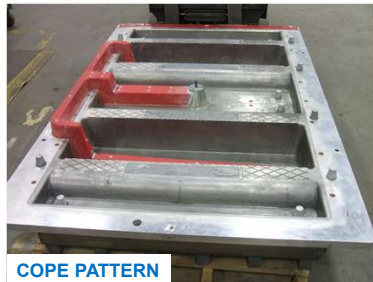
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9

Basic Casting and Foundry Principles

- Patterns

- Materials for patterns includes:
 - Aluminum, steel, iron, plastics and wood
- CNC machines



10

10

Basic Casting and Foundry Principles

- Molding



11

11

Basic Casting and Foundry Principles

- Inserts



12

12

Basic Casting and Foundry Principles

• Casting

- molten iron is poured
 - 2500°F
- cools in the mold
- shake out



Molten iron is poured into the mold



Casting cools in the mold for 2-4 hours



Casting exiting sand shakeout system

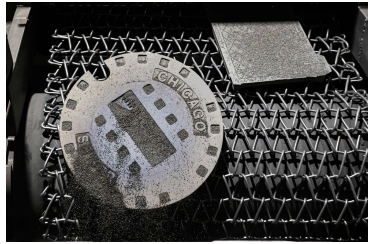
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13

Basic Casting and Foundry Principles

• Cleaning and Machining

- Shot Blast
- Grinding
- Machining



Castings existing shot blast



Grinding of newly cast parts



Casting being machined

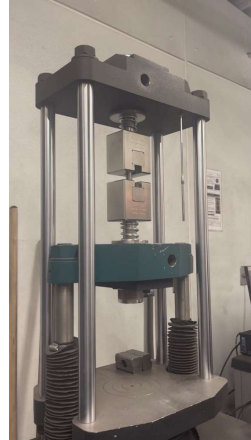
14

14

Basic Casting and Foundry Principles

• Manufacturing Quality Control

- Test Bars
 - every 4 hours
 - tensile properties meet ASTM requirements
- Iron Chemistry
 - elements within the iron are acceptable, mass spectrometer
- Part Conformance
 - x-ray, soundness testing, hardness testing and dimensional accuracy



Tensile Test



Test Bar

15

15

Cast Gray and Ductile Iron Material Properties

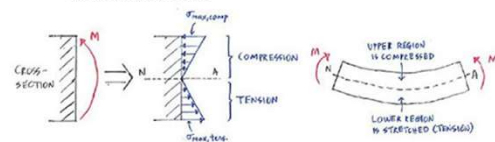
• Cast Gray Iron - most common for infrastructure

- ASTM A48 Class 35B
 - Tensile Strength = 35,000 psi, B Size Test Bar
- 3-4 times as strong in compression as in tension
- not flexible or ductile
 - yield is nearly the same as it's tensile strength
- easy to machine, economical to produce and provides the necessary strength for infrastructure

Bending stress

$$\text{Formula: } \sigma_b = -\frac{My}{I} \quad (\text{Units: Pa or MPa})$$

Stress distribution:



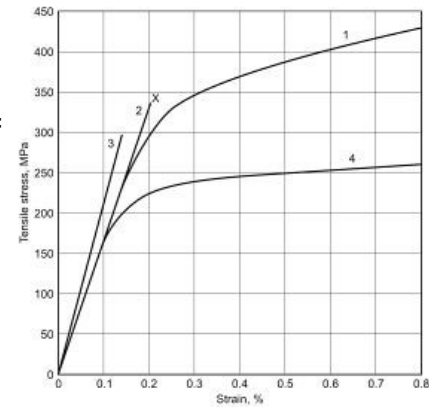
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16

Cast Gray and Ductile Iron Material Properties

• Cast Ductile Iron – High Loading

- ASTM A536 Grade 80-55-06
 - Tensile Strength = 80,000 psi, Yield Strength = 55,000 psi, Elongation at Break = 6%
- 3-4 times as strong in compression as it is in tension
- flexible, and provides higher strength
- contains more alloys than gray iron, making it more difficult to machine and pour



17

17

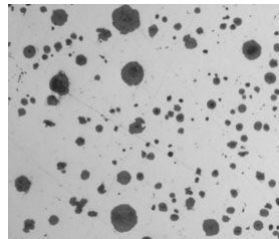
Cast Gray and Ductile Iron Material Properties

• What are the major differences between Gray and Ductile Iron?

- graphite molecule formation
 - flakes
 - spheres



Cast gray iron microstructure



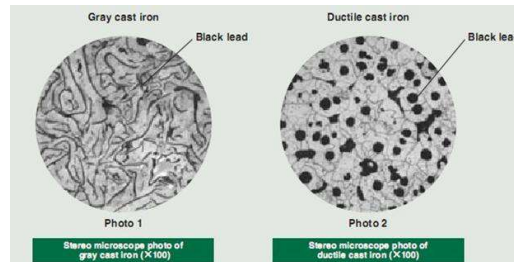
Cast ductile iron microstructure

18

18

Cast Gray and Ductile Iron Material Properties

- Gray Iron:
 - easier to machine
 - cheaper to produce
 - provides better vibration damping
- Ductile Iron:
 - stronger than gray iron
 - can sustain higher load ratings



19

19

Cast Gray and Ductile Iron Material Properties

- Cast Gray and Ductile Iron Corrosion



New Casting



Partial exposure to wetting



Full surface oxidation



Black iron oxide and silicate subscale is forming



Patina

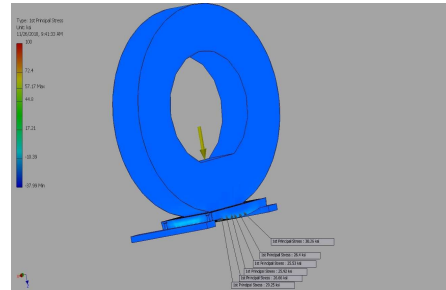
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20

Load Ratings

• Introduction

- extremely important to consider
- Improperly designed or utilized castings may result in a failure
 - property damage, injury or death



21

21

Load Ratings



- 3 main categories:
 - Pedestrian or Light Duty
 - Traffic Rated
 - Extra Heavy Duty
 - verified through FEA and physical load testing
- **Load ratings and proof loads are different! Proof loads are the test loads that include a safety factor above the rated load.**

22

22

Load Ratings

• Load Rating Standards

- **AASHTO M306, Standard Specification for Drainage, Sewer, Utility and Related Castings**
- FAA AC 150/5320-6G, Advisory Circular for Airport Pavement Design and Evaluation
- US General Services Administration Commercial Item Description (CID) A-A-60005, Frames, Covers, Steps, Sump and Catch Basin, Manhole
- EN 124, Gully Tops and Manhole Tops for Vehicular and Pedestrian Areas

AASHTO



GSA



EUROPEAN COMMITTEE
FOR STANDARDIZATION

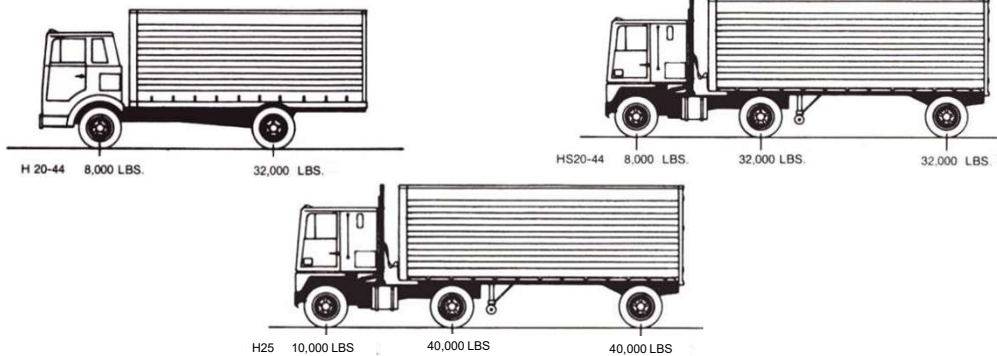
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23

Load Ratings

• AASHTO M306

- for highway and vehicle loading requirements
- **AASHTO Design Vehicles**



24

24

Load Ratings

• AASHTO M306 Load Testing and Casting Performance Requirements

- 2.5 times the rated load
 1. The proof load used, simulating a tire, 9" x 9"
 2. Loading rate: 100 and 1,000 lbs/sec
 3. The load is held for 1 minute and then released
 4. Inspection to determine if cracking or damage occurred
 5. Permanent deformation after loading may not exceed 1/8"



25

25

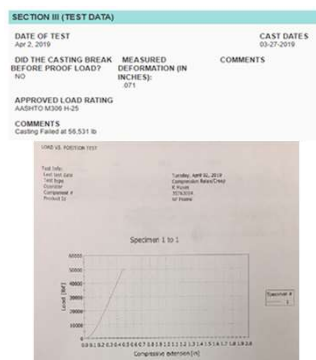
AASHTO & ASTM Standards

AASHTO M306 (Load Test)

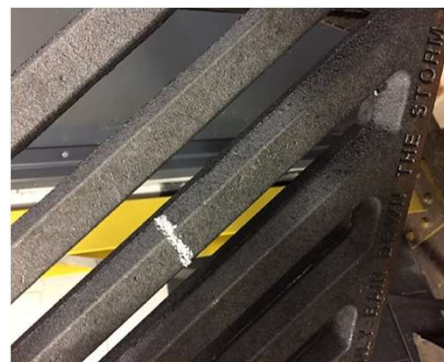
- hydraulic press



Grate and Frame Pre-Test Setup



Load Testing Graphs



Identification of failure area on casting.

26

26

Load Ratings

• FAA AC 150/5320-6G

- withstand a 100,000-pound wheel load at a tire pressure of 250 psi
 - correlates to a 20" x 20" contact area
- AASHTO M306 test procedure provides a safety factor of 9.8
- actual loading is 50-60k pounds, resulting in a factor of safety of about 16.4



27

27

Load Ratings

• EN 124

- international standard
- has more load rating designations than AASHTO, from pedestrian to extra heavy duty
- test area size is different - based on the span of the casting
- specifies the casting be loaded and unloaded at different intervals of both load and time

EN 124 Load Rating Class	Load Rating (kN)	Load Rating (lbs)
A15	15	3,372
B125	125	28,101
C250	250	56,202
D400	400	89,923
E600	600	134,885
F900	900	202,328

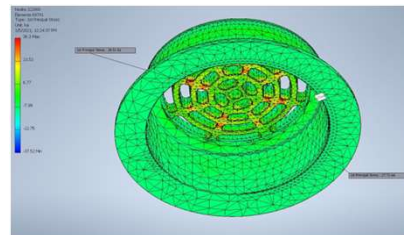
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28

Load Ratings

• Performance Based Design

- Over Designed Castings – the Past
 - Tooling costs
 - Design calculations took time
 - Consistency was less controlled
 - Raw materials and energy were inexpensive
- Less Material in Castings - New Design
 - Saves raw material costs and reduces energy consumption
 - Reduces shipping costs
 - Increases ergonomics

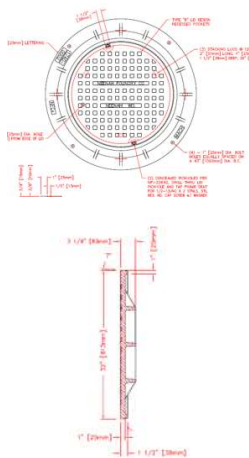


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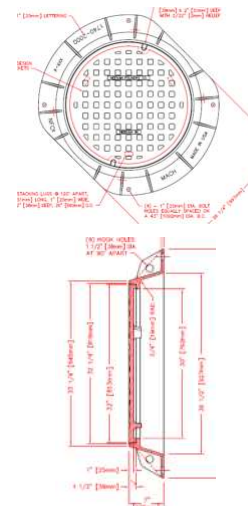
29

Load Ratings

• Platen v Ribbed



	OLD UNIT	NEW MODERNIZED UNIT	IMPROVEMENT
FRAME WEIGHT	357 LBS	216 LBS	40% Weight Reduction
LID WEIGHT	327 LBS	223 LBS	40% Weight Reduction
UNIT WEIGHT	684 LBS	439 LBS	40% Weight Reduction
ULTIMATE LOAD CAPACITY	69,200 LBS	100,700 LBS	45% Increase Load Capacity



30

30

Summary of Cast Iron

- Manufacturability – Castings need to have appropriate draft angles, fillets, radii to be moldable
- Material selection – Gray or Ductile iron
- Load Rating
- Coatings
- Platen v Ribbed

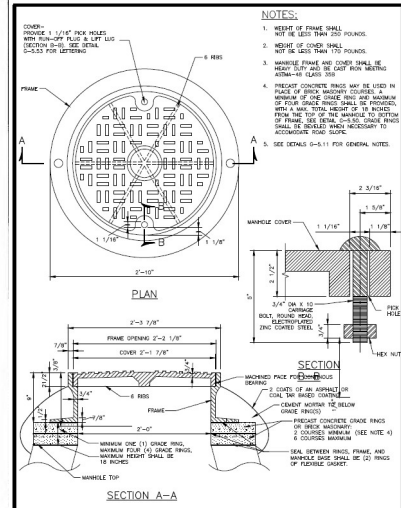
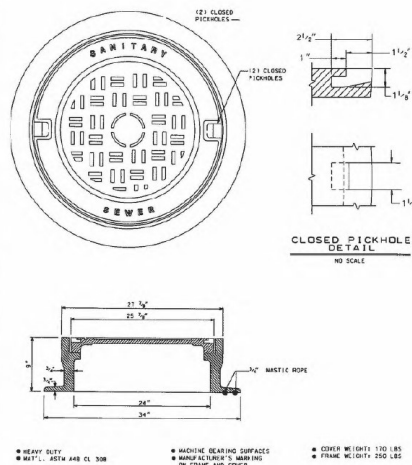


31

31

Standardization of Castings for CEAM

- Review of all County Standards
 - Inlet Grates and Frames are generally the same for each County
 - Manhole frames and covers are consistent in critical dimensions, but vary widely in:
 - Weight
 - Surface Design
 - Pick Style
 - Lettering
 - Rib Location and Design

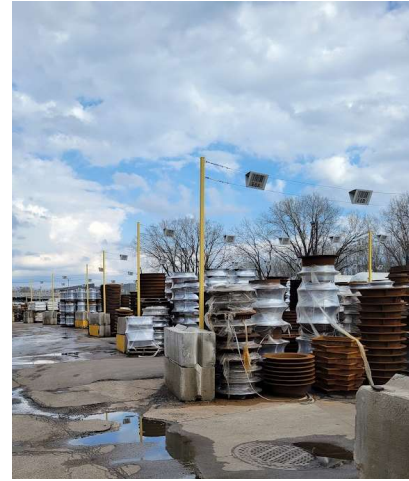


32

32

Standardization of Castings for CEAM

- Why Standardize?
 - Increase interchangeability
 - Increase manufacturing efficiency
 - Reduce chance for mistakes
 - Decrease lead time
 - Decrease complexity in the field



33

33

Standardization of Castings for CEAM

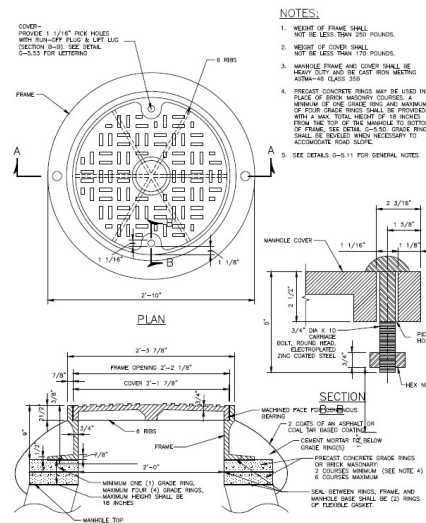
- Proposed Standardization Items
 - Remove weight requirements for frames and lids
 - Reduce pick styles to two types, one open, one concealed
 - Reduce to one design per manhole cover size
 - Allowance for engraved lettering versus raised

34

34

Standardization of Castings for CEAM

- Remove weight requirement for frames and lids
 - Weight does not equate to strength
 - Removing weight reduces energy consumption
 - Increased ergonomics and reduced worker compensation claims
 - Switch to load rating versus weight requirement
- Example Howard County
 - Current Lid Weight = (min) 170 lb
 - Current Frame Weight = (min) 250 lb
 - Proposed Lid Weight = 157 lb (approx.)
 - Proposed Frame Weight = 140 lb (approx.)
 - Remove ribs and move to platen lid



35

35

Standardization of Castings for CEAM

- Control of Import Casting Quality Issues
 - Institute Buy America requirement for iron and steel
 - Follow AASHTO M306 Section 8 "Inspection"
 - Import castings require proof load test and cast-on test bars
 - Domestic castings require proof load test and separately cast test bars
 - Done through certifications
 - Implement a no-paint policy
 - Importers can hide defects by painting

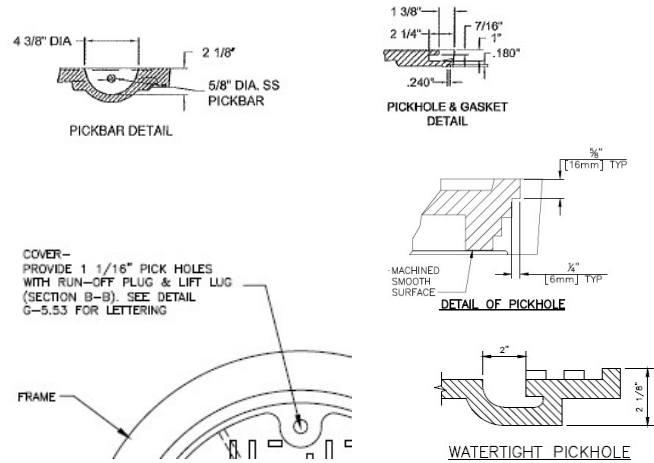


36

36

Standardization of Castings for CEAM

- Standardize manhole pick styles
 - Currently 5 different styles
 - 2 different hole diameters
 - Varying locations
- Recommend two styles
 - One open pick
 - One concealed pick
- Recommend standard locations

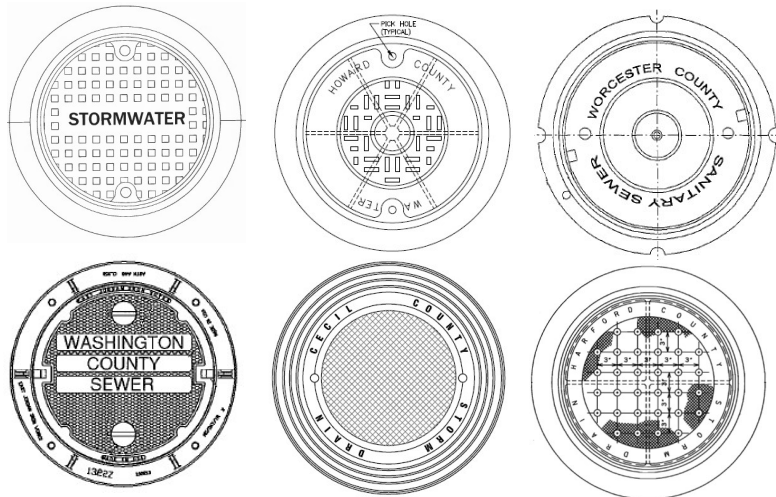


37

37

Standardization of Castings for CEAM

- Standardize Surface Design
 - Currently 6+ designs
 - Pick locations vary
 - Lettering height and location vary
- Recommendations
 - One design per size
 - Standardize lettering
 - Standardize picks and locations
 - Discuss need for vented lid

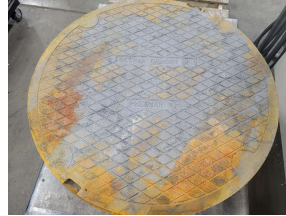


38

38

Standardization of Castings for CEAM

- Current Lettering
 - Raised lettering in a recessed pocket
 - Several different fonts
 - Multiple sizes
 - Varying Locations
- Recommendations
 - High volume castings continue casting lettering
 - Low volume (less than 15 per order) allow engraved lettering
 - Standardize lettering location
 - Standardize font type and size



39

39

QUESTIONS?

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40