# Design of Mercury Storage Containers

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# Mercury Storage Container Design Standards

- **The ASME Boiler & Pressure Vessel Code does not apply**
  - **Containing pressures under 15 psig (100 kPa above atmosphere). None of these containers will reach that pressure under normal static circumstances. However, the containers still could be designed, manufactured, and tested to this standard.**
- **All containers are designed for elemental mercury (99.5% by volume, or better)**
  - **The impurities in the mercury should not be capable of corroding carbon or stainless steel (i.e., nitric acid solution, chloride salts solutions, or water).**
- **Protective coating should be applied to the exterior surface of the containers**
  - **Epoxy paint**
  - **Electro plating**
  - **No protective coating is required for the inner surface as long a mercury meets purity requirements and no water is present inside the container.**

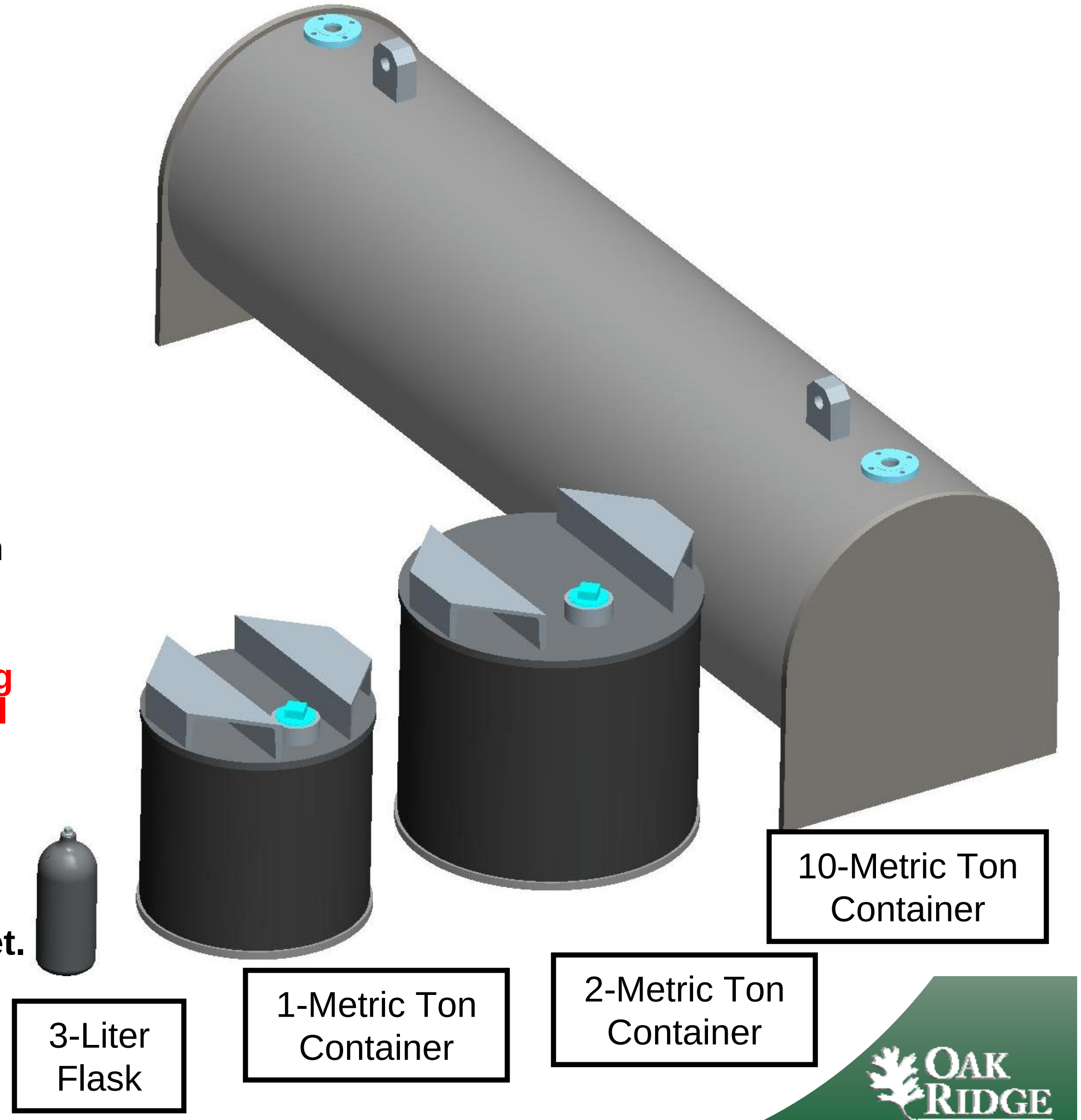
# Mercury Storage Container Transport Standards

- **International Air Transport Association (IATA) Packing Instruction 803 allows transporting flasks containing less than 35 kg of mercury.**
  - **The flask must pass the 95 kPa pressure test for liquids by air (IATA 5.0.2.9).**
- **International Maritime Dangerous Goods (IMDG) Code (Amendment 33-06), Packing Instruction P800 (version valid until December 31, 2009) allows transport via ocean vessels for flasks containing less than 3.0 L of mercury.**
- **Larger container must be transported by ground if code allows.**

# Mercury Storage Container Design Considerations

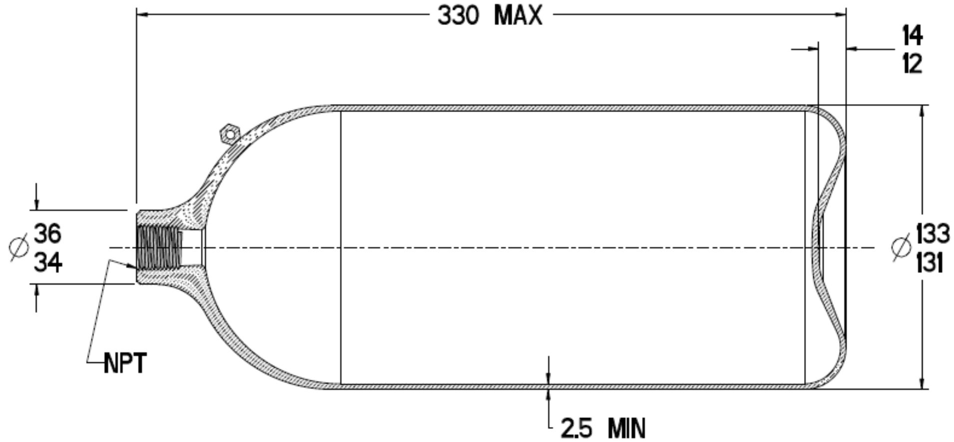
- **Reliability of the container should be considered in all design decisions.**
- **Depth of mercury should less than**

  **0.7 m from the top of fill port. The maximum a vacuum pump can raise mercury is 0.76 m.**
- **Avoid using a drain valve to allow mercury removal from container. The addition of the valve reduces reliability.**
- **Welds are likely to be the weakest point in container and require greater focus in design and quality control during manufacturing.**
- **Use of a National Pipe Thread (NPT) plug with Teflon® tape provides excellent seal at low cost.**
- **The use of two ports on top of the container may provide the fastest filling method (as shown on 10-MT example). One port is connected with a vacuum pump while the other is the mercury inlet.**



# 3-Liter Flask

- **Allowable Metals**
  - **Carbon Steel (ASTM A36 minimum)**
- **Container Design**
  - **Seamless container (no welding, similar to gas cylinder)**
  - **Interior volume between 2.9 L to 3.5 L**
  - **Estimated empty mass, 9 kg**
- **No Welding**
  - **Welded seams are commonly weak locations on the flask**
- **Conclusions**
  - **Provides the highest cost per volume of mercury stored.**
  - **Good choice for small mercury generators. Easy to transport by ocean vessel, ground, or air**
  - **Would need to be stored in box pallet, typically 49 flask per pallet (pallet size 1.25 m x 1.25 m)**



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# 3-Liter Flask Examples

MERSADE (Europe)

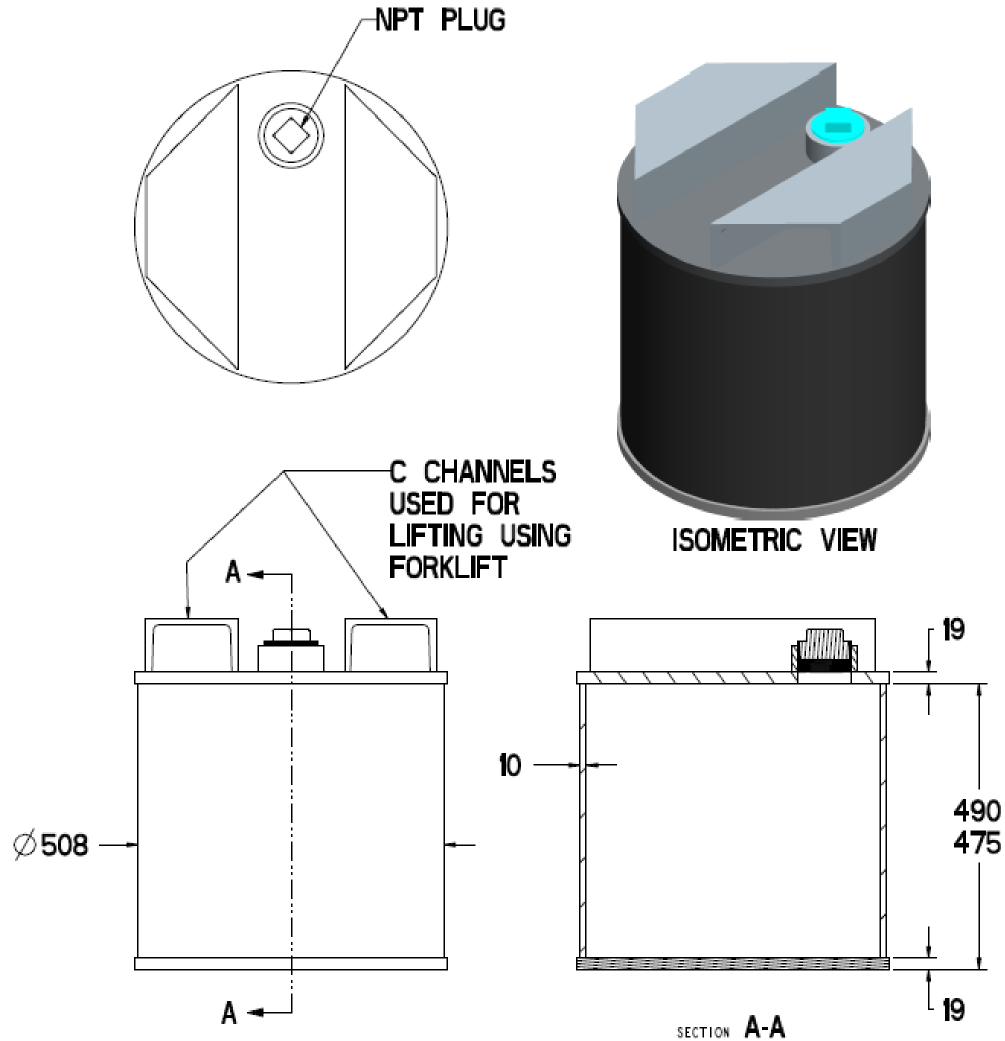
U.S. Industry Produced

DLA Flask Examples

- **Defense Logistics Agency (DLA) has approximately 128,000 3-L flasks**
- **Majority of the flasks are a weldment design**
- **Most flasks are more than 50 years old**
- **More than 30 different design types with varying quality and condition**
- **Some were hydrostatically pressure tested with typical results from (4 MPa to over 15 MPa)**

# 1-Metric Ton Container

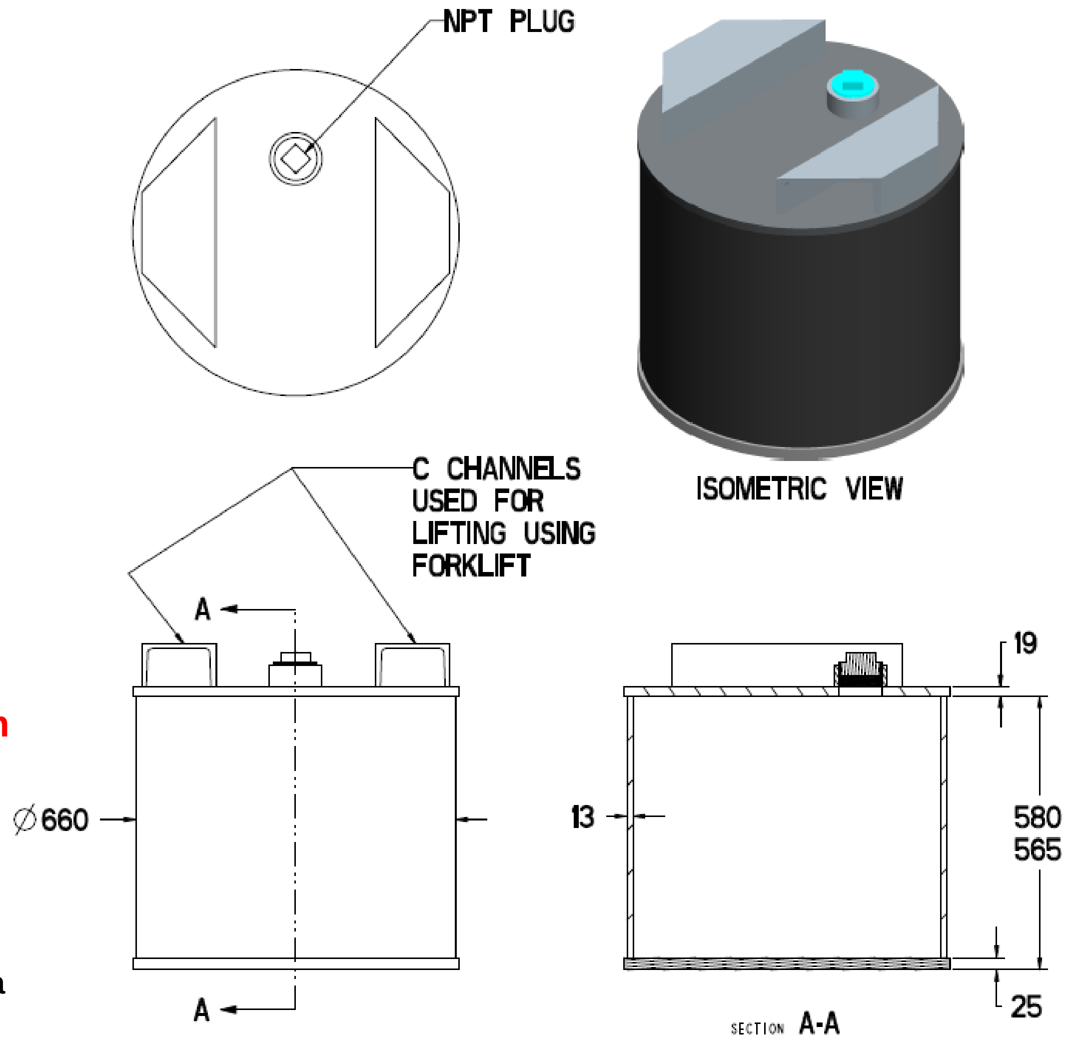
- **Allowable Metals**
  - **Carbon Steel (ASTM A36 minimum)**
  - **Stainless steel (not recommended)**
    - **More than twice the cost**
    - **Lower material strength**
    - **Provides better exterior corrosion protection over the carbon**
- **Welding**
  - **AWS D1.1 – *Structural Welding Code - Steel***
- **Container Design**
  - **C-channels allow for handling using a forklift**
    - **C-channels on top of container to allow for easy placement on a spill tray; lower lift position would be blocked by side of spill tray.**
  - **Maximum 1,000 kg of mercury**
  - **Estimated empty mass, 135 kg**
  - **Standard pipe diameter and plate thicknesses to reduce cost**
- **Protective Coating from Exterior Corrosion**
  - **Epoxy based paint**
- **Conclusions**
  - **Reduces cost per volume of mercury stored when compared to 3-L flasks**
  - **Easy to transport and handle with a forklift**




Dim's in mm

# 2-Metric Ton Container

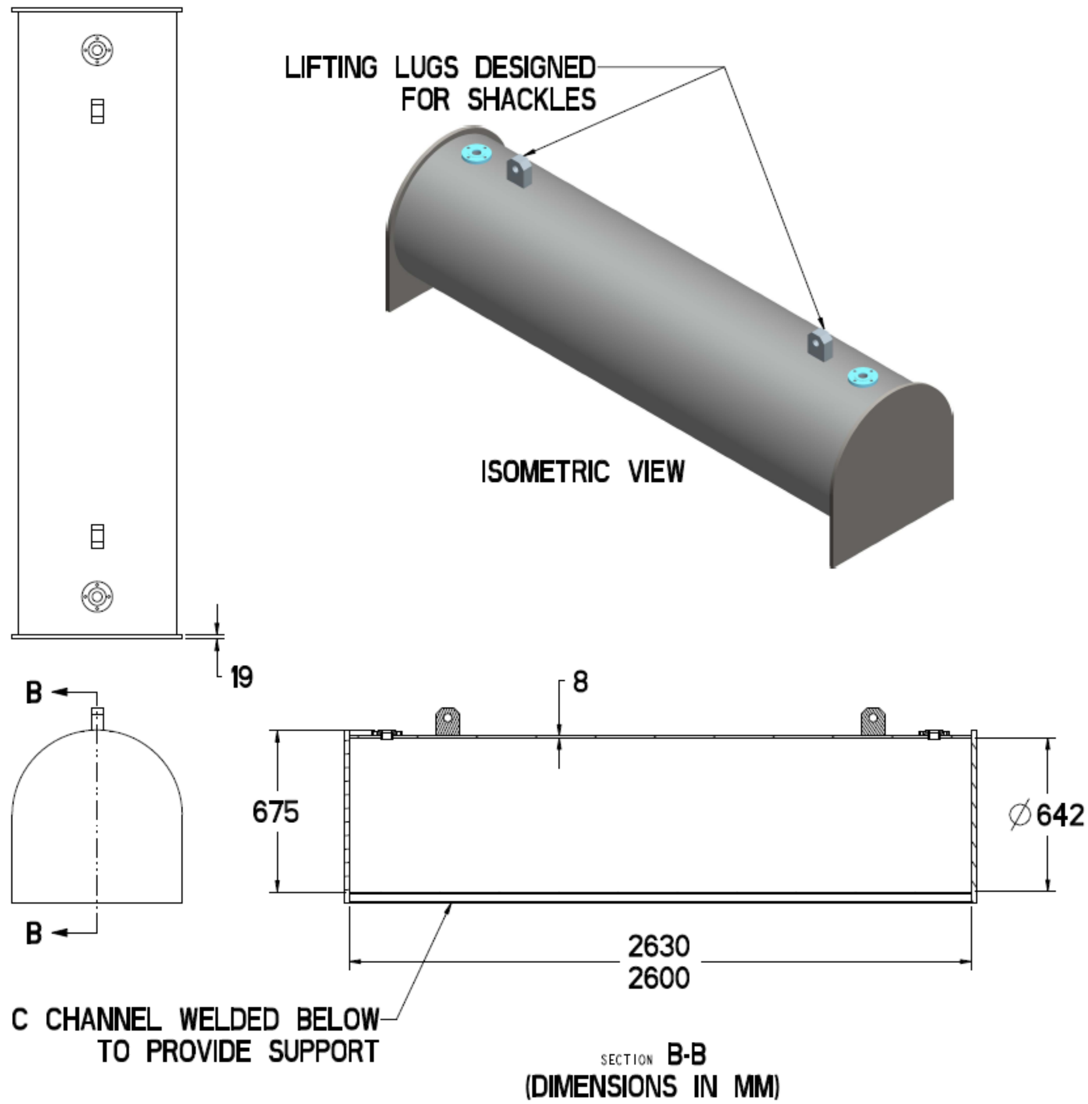
- **Allowable Metals**
  - **Carbon Steel (ASTM A36 minimum)**
  - **Stainless steel (not recommended)**
    - **More than twice the cost**
    - **Lower material strength**
    - **Provides better exterior corrosion protection over the carbon**
- **Welding**
  - **AWS D1.1 – *Structural Welding Code - Steel***
- **Container Design**
  - **C-channels allow for lift using a forklift**
  - **Maximum 2,000 kg of mercury**
  - **Estimated empty mass, 250 kg**
  - **Base plate thicker than 1-MT**
  - **Standard pipe size to reduce cost**
- **Protective Coating from Exterior Corrosion**
  - **Epoxy based paint**
- **Conclusions**
  - **Reduced cost per volume of mercury stored when compared to 1-MT containers**
  - **Requires a medium duty forklift but still easily handled during transport and inside a facility**




Dim's in mm

# 10-Metric Ton Container

- **Allowable Metals**
  - Carbon Steel (ASTM A36 minimum)
  - Stainless steel
    - More than twice the cost
    - Lower material strength
    - Provides better exterior corrosion protection over the carbon
- **Welding**
  - AWS D1.1 – *Structural Welding Code - Steel*
- **Container Design**
  - Maximum 10,000 kg of mercury
  - Estimated empty mass is 500 kg
  - Standard pipe size to reduce cost
  - C-channels welded under the pipe to provide support
  - Lifting lugs for transport, however best to fill container in final storage position
- **Protective Coating from Exterior Corrosion**
  - Epoxy based paint
- **Conclusions**
  - Difficult to transport container after filled with mercury
  - Provides the lowest cost of container per volume of mercury



# Conclusions

| Container Sizes | Container Empty Mass (kg) | Maximum Mercury Contained (kg) | Efficiency Index (Mercury Contained / Container Empty Mass) | Estimated Floor Space Area ($m^2$) for 10,000 MT of Mercury Storage[a] |
|---|---|---|---|---|
| 3-L Flask | 9 | 35 | 3.9 | 9,500 |
| 1-MT Container | 135 | 1,000 | 7.4 | 3,600 |
| 2-MT Container | 250 | 2,000 | 8 | 2,500 |
| 10-MT Container | 500 | 10,000 | 20 | 1,900 |

[a]Floor space required for containers only, does not include space required for aisle ways, assumes 3-L flasks are in box pallets, 49 flask per pallet.

- **3-L Flask**
  - **Ideal for use by small generators (e.g. fluorescent lamp recyclers)**
  - **Lowest Efficiency Index, greatest amount of steel use for storing mercury increasing cost**
- **1-MT Container**
  - **Best for transportation and handling, most forklifts capable of lifting load**
  - **Improved Efficiency Index over 3-L flasks**
  - **Greatly reduces floor space requirements**
- **2-MT Container**
  - **Good for transportation and handing**
  - **Slightly better Efficiency Index over 1-MT container**
  - **Reduced floor space requirements by approximately 30% from 1-MT container**
- **10-MT Container**
  - **Poor for Transportation and handling, difficult to handle after filling, designed to be filled in final storage location**
  - **Highest Efficiency Index, likely lowest total container cost of the total options**
  - **Requires the least amount of floor space**