Experiences on Japanese regulation for superconducting accelerator

Asian Linear Collider Workshop 2018 (ALCW2018)

Advanced equipment Designing Section
Accelerator Team
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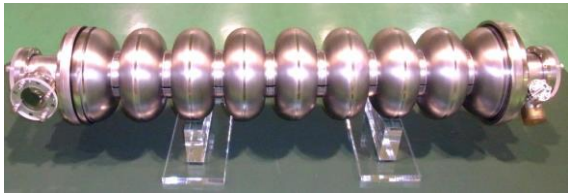
1. Superconducting cavities of MHI-MS(MHI)

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

1989 KEK-TRISTAN (delivery)


2005 KEK-STF (start)



2007 KEK-CRAB (delivery)


2012 KEK-cERL (delivery)



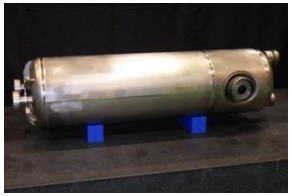
Photo courtesy of KEK


Photo courtesy of KEK

2015 Business succession

MHI ⇒ MHI-MS

2015 RIKEN-RIBF (start)



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2.1 Regulation for Superconducting accelerator

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

(1) Act on Prevention of Radiation Hazards due to Radioisotopes, etc.

- The point of view of radiation

(2) High Pressure Gas safety act

- Superconducting accelerators use the liquid helium for cooling
- The act is applied to the items which contact the liquid helium.
- This act has several categories. Required inspections are changed by the categories.

- The General High pressure safety Ordinance
  ⇒ General items (Pipes, small vessels, valves etc.)
- The Designated Equipment Inspection Ordinance
  ⇒ High pressure or Large volume vessel
- The Refrigeration Safety Ordinance
  ⇒ Superconducting accelerator is treated as the part of helium refrigerator.

etc.

2.1 Regulation for Superconducting accelerator

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

1989 KEK-TRISTAN (delivery)

2005 KEK-STF (start)

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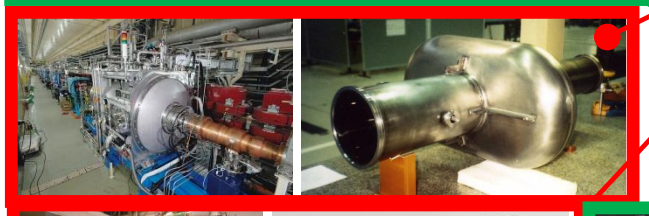
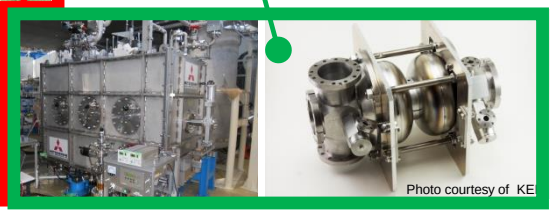
Equipment Ordinance



General Ordinance



Refrigerator Ordinance

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High pressure gas safety act (since 1951)

- This act doesn't assume the superconducting devices

◆ Allowable materials
Niobium and Niobium titanium alloy are not include

◆ Allowable temperature of materials
(ex. SUS316L ≧4.2K[-269degreeC])
All material not be allowed 2K(-271degreeC)

◆ Formulas of vessel thickness
Formulas cannot be applied to cavity shape

◆ Required Inspections
(ex. Material inspection, RT, PT, Pressure test, etc.)
Several test cannot be applied for cavities
ex. RT cannot apply the dissimilar metal welding

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

High pressure gas safety act (since 1951)

- This act doesn't assume the superconducting devices

◆ Manufacturer makes the new standard based on the scientific evidences and has to get the permission from public institution for high pressure gas safety.

Ex.

Niobium
- Tensile test
- Vending test
- Impact test

→

We prove that niobium has enough strength for high pressure vessel

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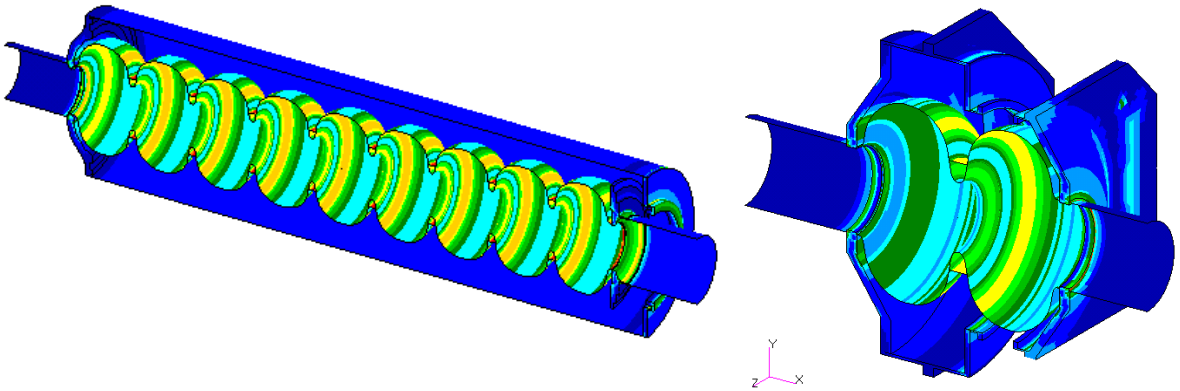
●Inspection

Design
-Calculation
-Analysis
-High pressure test



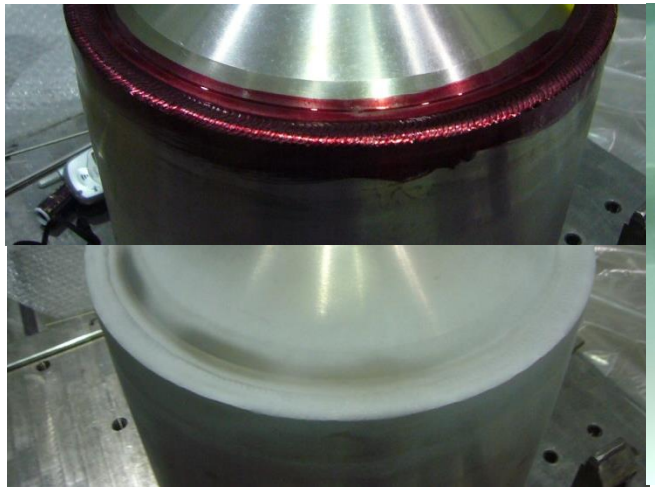
3. Inspections for High pressure gas safety act

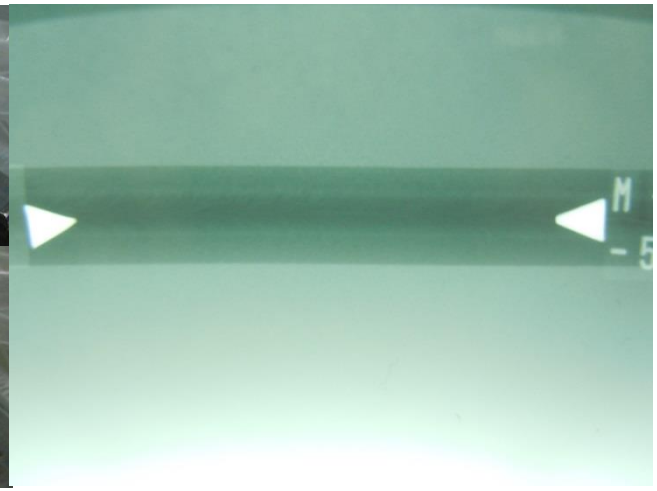
MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

●Inspection

Material

Welding
-Penetrant test
-Radiographic test





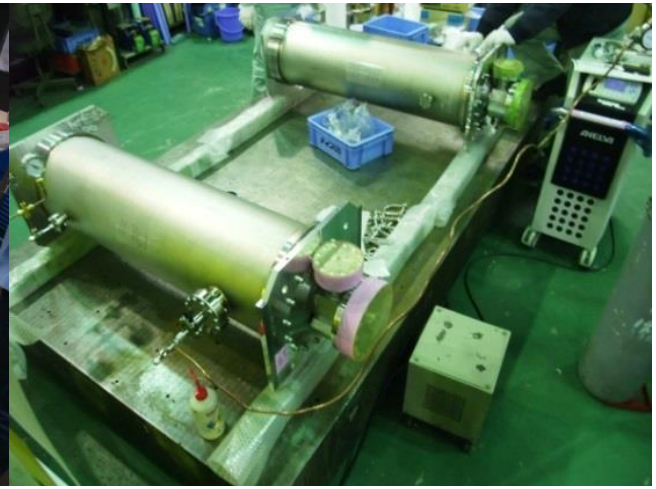
3. Inspections for High pressure gas safety act

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

●Inspection

Mechanical test
-Tensile test
-Bend test

Structure
-Pressure test
-Gas leakage test



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4. Study item for ILC

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◆ Uniform standards in the world

High Pressure Gas Safety law ⇔ ASME

⇔ Pressure Equipment Directive ⇔ others

◆ New standards for ILC

- Inspections during fabrication
- Inspections for export items
- Valid period of certificate

We need discussion with the government, the High Pressure Gas Safety Institute of Japan, Scientist, manufacture, and neighborhood.

Summary

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

(1) MHI-MS has fabricated the superconducting accelerators for several project under the High pressure safety act in Japan.

(2) Manufacture has to make new standard to apply the High pressure gas safety act for superconducting accelerator.

(3) We should make new suitable standard for ILC before construction start.

MOVE THE WORLD FORWARD

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High pressure gas safety act (since 1951)

- This act doesn't assume the superconducting devices

Regulation

- Allowable material → Not include Niobium
- Allowable temperature of material → Not cover under 4.2K
- Formulas for vessel thickness → Cannot apply the cavity shape
- Inspections during fabrication → Cannot do several inspections
  material test, dimensional test
  RT, PT, pressure test, etc..

etc.

Superconducting cavities

- Not include Niobium
- Not cover under 4.2K
- Cannot apply the cavity shape
- Cannot do several inspections

- Manufacturer makes the new regulations based on the scientific evidences and has to get the permission from public institution for high pressure gas safety.

Japanese Law Transition: http://www.japaneselawtranslation.go.jp/?re=02
The High Pressure Gas Safety Institute of Japan: https://www.khk.or.jp/english/index.html

1. Japanese regulation for accelerator

MITSUBISHI HEAVY INDUSTRIES MACHINERY SYSTEMS

High pressure Gas safety act

- General High Pressure Gas Safety Ordinance (General Ordinance)
- Designated Equipment Inspection Ordinance (Equipment Ordinance)
- Refrigeration Safety Ordinance (Refrigeration Ordinance)
- Liquefied Petroleum Gas Safety Ordinance (LPG Ordinance)
- Container Safety Ordinance (Container Ordinance)
- Industrial Complex Safety Ordinance (Industrial Ordinance)

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