

Versatile Hot Cell Design

HOTLAB 2013

Greg Sprenger, Merrick & Company
Francisco Granadino, Merrick & Company
Nuclear Services & Technology

September 25, 2013

Engineering | Architecture | Design-Build | Surveying | Planning | GeoSpatial Solutions



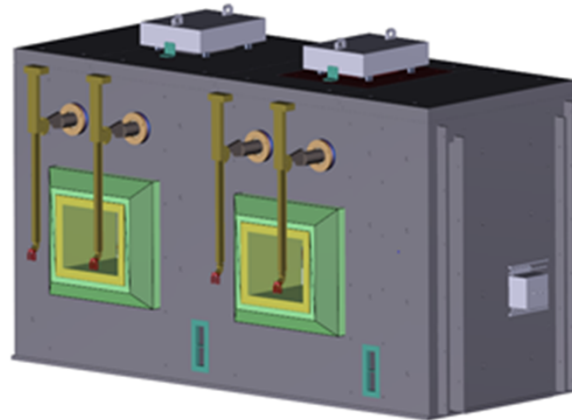
Presentation Agenda

- What is Versatile Hot Cell Design?
- Define Current Requirements
- Define Possible Future Needs
- Designing Hot Cells for Versatility
 - Shielding Construction
 - Remote Manipulation
 - Viewing
 - Penetrations
 - Transfer Ports

Versatile Hot Cell Design

What is Versatile Hot Cell Design?

Hot cell design that focuses on adaptability and cost efficiency during construction, operation and decommissioning, while providing forward compatibility for possible repurposing on future missions.



Hot Cell Requirements

Define Current Program Requirements

- Shielding Requirements
- Layout and Volume Requirements
- Remote Handling Requirements
- Viewing Requirements
- Penetration Requirements
- Material Transfer Requirements
- Consider Program Evolution
- Maintain Vision of Versatility

Hot Cell Requirements

Define Possible Future Requirements

- Difficult to Predict the Future but Future Needs Should Be Considered
- Versatility Makes Changes or Modifications Easier
- May lead to Repurposing of Hot Cell System
- Results in Lower Overall Life Cycle Cost

Hot Cell Versatility

Designing for Hot Cell System Versatility

Designing for hot cell versatility is challenging but worth the effort. The added investment provides additional options for the hot cell at the end of the current mission. Design versatility should consider the following:

- Hot Cell Shielding Construction
- Hot Cell Remote Manipulation
- Hot Cell Viewing
- Hot Cell Penetrations
- Hot Cell Transfer Ports

Hot Cell Shielding Construction

There are several options in designing hot cell shielding. Each of these shielding designs has their advantages and disadvantages that should all be considered. Some of the options to be discussed are:

- Cast in Place Concrete Construction
- Lead and Stainless Steel Construction
- Steel-Concrete-Steel Construction
- Laminated Steel Plate Construction

Hot Cell Shielding Construction

Cast in Place Concrete Construction

- Cast in place concrete construction is common within the industry.
- This construction method utilizes standard or high density concrete, fabricated penetrations, imbeds and temporary forms.

Hot Cell Shielding Construction

Advantages of Cast in Place Concrete Construction

- Lowest initial cost of the construction alternatives
- Due to the low relative density of the concrete, penetration design to meet the shielding requirements is easy

Hot Cell Shielding Construction

Disadvantages of Cast in Place Concrete Construction

- Difficult to modify
- Difficult to recycle or reuse during decommissioning
- Difficult to control dimensionally
- Requires the most time in construction schedule

Hot Cell Shielding Construction

Lead and Stainless Steel Construction

- Lead and stainless steel construction is also quite common within the industry.
- This construction method utilizes lead brick or plate with a stainless steel sheath.

Hot Cell Shielding Construction

Advantages of Lead and Stainless Steel Construction

- High density of lead provides for thinner wall sections

Hot Cell Shielding Construction

Disadvantages of Lead and Stainless Steel Construction

- Difficult to structurally qualify
- Difficult to decontaminate, recycle or reuse during decommissioning
- Difficult to control dimensionally and modify in future
- Poses a concern regarding fire and lead melting
- Due to the high density of the lead, penetration design to meet the shielding requirements is more complicated
- Material cost is significantly higher (~10 times) than Steel-Concrete-Steel construction

Hot Cell Shielding Construction

Steel-Concrete-Steel Construction

- Steel-concrete-steel construction utilizes leave in place fabricated steel forms.
- Steel forms are filled with either standard or high density concrete.

Hot Cell Shielding Construction

Advantages of Steel-Concrete-Steel Construction

- Steel reduces the thickness of the walls compared to standard concrete
- Due to the low relative density, penetration design to meet the shielding requirements is easy
- Relatively easy to qualify structurally
- Construction schedule can be reduced by allowing fabrication of the forms to occur in parallel with facility construction
- Higher control of feature tolerances since forms are fabricated in a shop

Hot Cell Shielding Construction

Disadvantages of Steel-Concrete-Steel Construction

- More difficult to modify than laminated steel construction
- Difficult to recycle or reuse during decommissioning
- Material cost is slightly higher than (<10%) standard concrete construction but significantly less than lead and stainless steel construction.

Hot Cell Shielding Construction

Laminated Steel Construction

- Laminated steel construction utilizes fabricated steel plates that are stacked.
- Laminated plates provide the hot cell structure and shielding function.

Hot Cell Shielding Construction

Advantages of Laminated Steel Construction

- Steel reduces the thickness of the walls compared to standard concrete
- Construction schedule can be reduced by allowing fabrication of the steel to occur in parallel with facility construction
- Relatively easy to qualify structurally
- Excellent forward compatibility and allowance for modifications
- Higher control of feature tolerances since forms are fabricated in a shop

Hot Cell Shielding Construction

Disadvantages of Laminated Steel Construction

- Material cost is higher (~5 times) than steel-concrete-steel construction but less than lead and stainless steel construction.

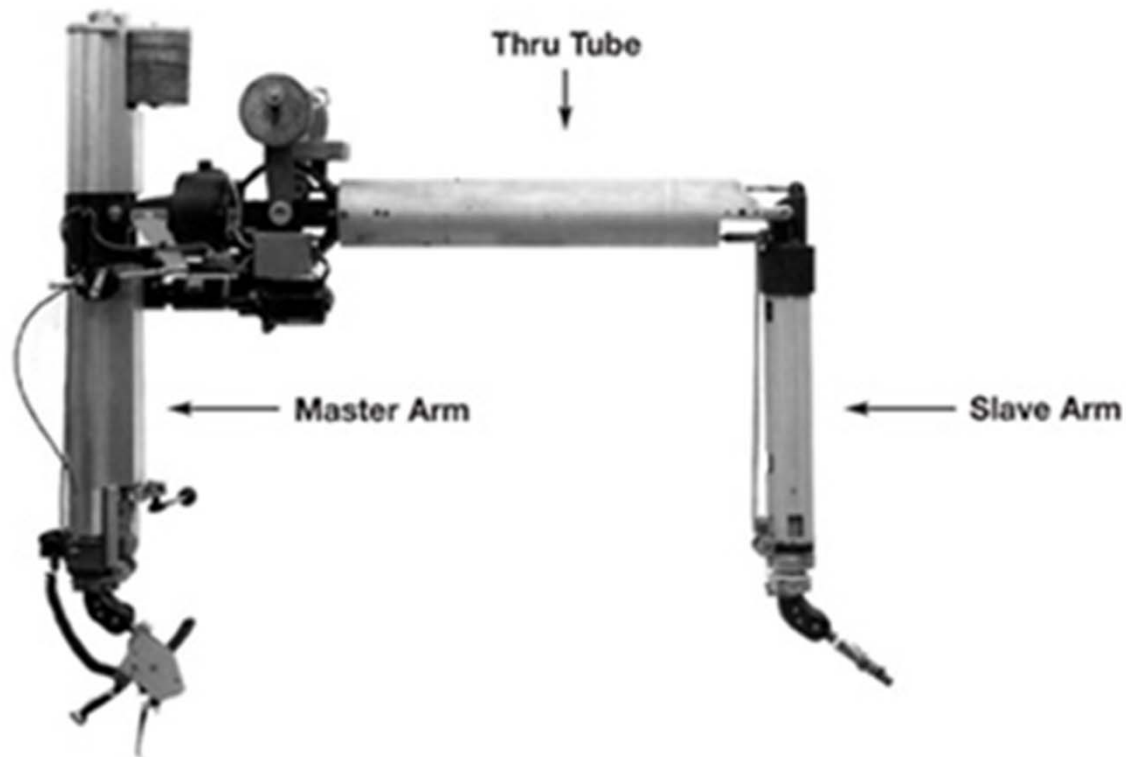
Hot Cell Remote Manipulators

Options for Hot Cell Remote Manipulators

- There are many options for manipulators used in hot cells.
- The selection of the remote manipulator should considered current and possible future needs of the hot cell.
- Advantages and disadvantages are depended on the different manufactures and include but are not limited to cost, reach, capacity, maintainability, and seal-ability.
- Some options are shown below.

Hot Cell Remote Manipulators

Telescoping Manipulator (Central Research Laboratories)



Hot Cell Remote Manipulators

Articulating Manipulator (Getinge-La Calhene)



Hot Cell Remote Manipulators

Tele-Operated Manipulator (Par Systems, Inc.)



Hot Cell Viewing and Lighting

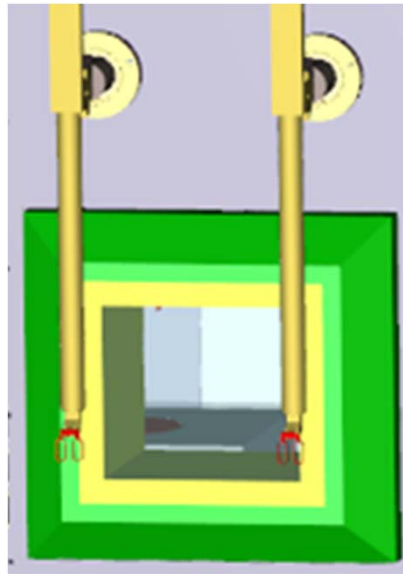
Hot Cell Viewing and Lighting

- There are several options to provide safe viewing of activities within the hot cell which requires shield windows or cameras and proper lighting.
- Design should consider both current and future needs in selecting the best solution.

Hot Cell Viewing and Lighting

Hot Cell Viewing Options

- Shield windows
- Cameras
- Combination of Shield window and Cameras



Hot Cell Viewing and Lighting

Hot Cell Lighting Options

- Internally Mounted Lights
- Externally Mounted Lights

	Internally Mounted Light	Externally Mounted Light
Advantages	No need for light window No need for supplemental shielding	Easier to replace or change No electrical penetration needed
Disadvantages	More difficult to replace Designed for remote replacement May need redundancy Needs electrical penetration	Needs light window Needs supplemental shielding

Hot Cell Penetrations

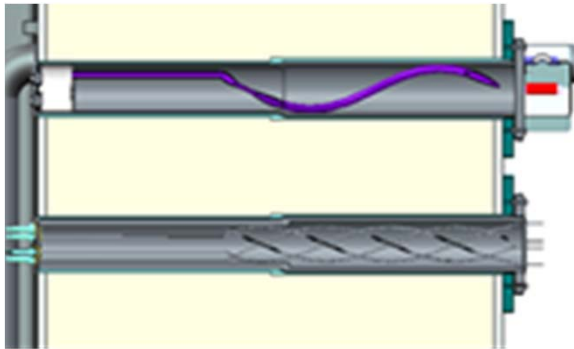
Hot Cell Penetrations

- Penetrations allow for utilities to enter and/or exit the hot cell interior while providing the necessary environmental and radiological protection.
- Several solutions exist for utility penetrations, some of which are shown below.

Hot Cell Penetrations

Hot Cell Penetration Options

- Spiral or Split Penetrations
- Versatile Industrial Penetration, may require supplemental shielding



Hot Cell Material Transfer Ports

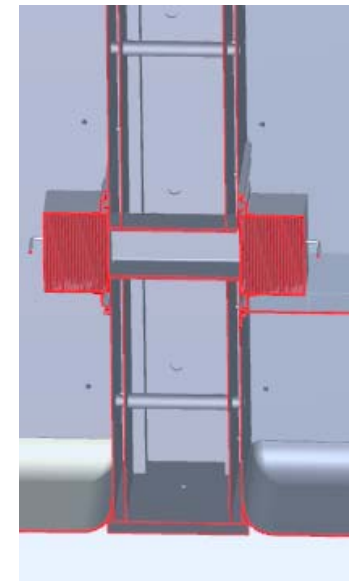
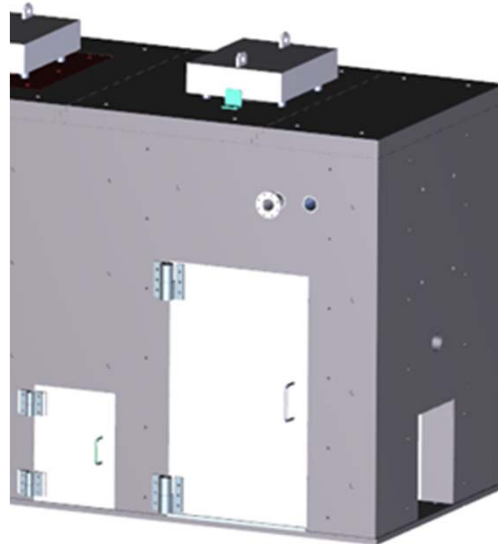
Hot Cell Material Transfer Ports

- Hot cell transfer ports provide a means of getting the specimens or product and any support items into or out of the hot cell.
- Design should consider both current and future needs in selecting the best and most flexible solution or solutions.
- Examples of solutions are shown below.

Hot Cell Material Transfer Ports

Hot Cell Material Transfer Port Options

- Commercial material transfer port solution (Getinge-La Calhene)
- Hot Cell Access Door
- Shielded Double Door Transfer Port / Airlock



Versatile Hot Cell Design

Conclusion

Providing versatility presumably has a slight increase in the design and capital cost but extends the usefulness of the hot cell system resulting in lower overall live cycle cost.