

# IceCube Upgrade Implementation Field Season Scenarios Analysis

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Logistics Review  
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- Alternate field season workplans
- Relationship of field seasons
- Additional seasons and their impact on South Pole operations



## 1) Repairs/Refit

### EHWD Refit:

- Cargo receiving – Gens 1-3, drill components, Firn Drill, etc.
- Repairs and upgrades
  - Controls (motor drives, sensors, PLCs, e-stops, cables)
  - Drill Control Center (DCC)
  - ARA Drill
  - Firn Drill
  - Water Tanks
  - Main Heating Plants (MHP)
  - High Pressure Unit (HPP)
  - Heater/Pump Unit (HPU)
  - Preheat system (PHS)
  - Tower, TOS1 & TOS2
  - Hose and cable reels
- Subsystem testing
- Power generation system repairs

## 2) Set-up, Integration & Commissioning

### Pre-drill Activities:

- Seasonal Equipment Site (SES) set-up
- Cargo receiving – drill components, cables, & string (x 2)
- Fuel system set-up
- Subsystem integration/testing
- Firn Drilling x 8 (40 meter depth)
- Initial Rod Well/condensate bulb development
- Surface cable installation x 7
- Main hose and hose heating system installation
- Power generation commissioning
- Preliminary wet-test

## 3) Drilling & Installation

### String Deployment:

- SES start-up
- ARA Drill Commissioning
- Rodwell development
- Tower Operations Site (TOS) set-up
- Drill Readiness Review
- Full system wet-test
- Deep drilling x 7
- String deployment x 7
- Bore hole logging x 1
- Trenching/cabling hole to SJB x 7
- Decommission and store EHWD
- Close-out

Repairs/Refit & SES Set-up

SES, Integration, & Commissioning

Drilling & Installation



- Six different field options retaining Upgrade's original scope (drill refit, 7 strings, & commissioning) were evaluated by developing workplans
  - Split drill seasons 2/5 holes
  - Small field team (50%) in FS1
  - Compressed 2 year schedule
  - 6-year project plan w/ 3 field seasons
  - 7-year project plan w/ 3 field seasons
  - Gap year schedule
- One scenario where drill refit was completed and mothballed w/o full integration/testing— original scope not retained
- We can plan around a wide variety of constraints, we just need to know what they are

### Similarities:

- Increased level of risk
- High population profile for multiple seasons
- Increased cost

### Differences:

- Number of field seasons
- Continuity/momentum

### Similarities:

- Field work activity approach
- 3 field seasons required
- Population profile

### Differences:

- Off-ice production rate
- Continuity/momentum
- Transportation & logistics tempos



Drilling operation with the IceCube Laboratory in the background



## Upgrade Plan Assumptions Comparison Table – Carefully Studied

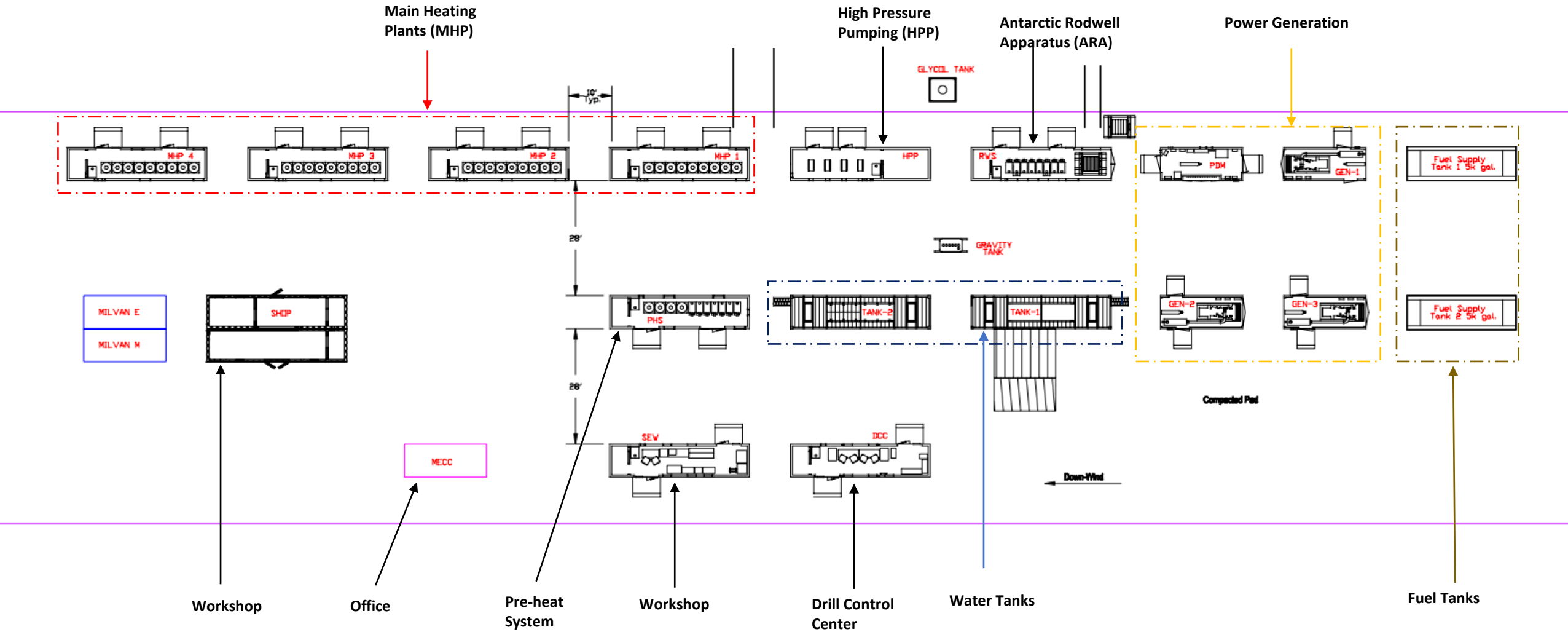
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6 Year	<ul style="list-style-type: none"> <li>• Optimized for installation in PY6</li> <li>• FY22-FY24 field seasons unrestricted</li> <li>• Intra/intercontinental cargo movements resume in earnest – cargo backlog moved from McMurdo to Pole, USAP vessel sails</li> <li>• South Pole bedspace to support the following headcounts (approximate): FY22 8-10, FY23 to 14-16 and in FY24 30-32 installation team members</li> <li>• Fuel available at the South Pole to support drilling in FY24</li> </ul>
7 Year	<ul style="list-style-type: none"> <li>• PY3-PY5 match the baseline plan, PY6 &amp; PY7 ramp up</li> <li>• FY22 field season canceled - USAP operations return to normal in FY23 and continue that way for the FY24, &amp; FY25 field seasons</li> <li>• Intra/intercontinental cargo movements resume at a moderate pace in FY22 – cargo backlog moved from McMurdo to Pole, USAP vessel sails</li> <li>• South Pole bedspace to support the following headcounts (approximate): FY23 8-10, FY24 to 14-16, and in FY25 30-32 installation team members</li> <li>• Fuel available at the South Pole to support drilling in FY25</li> </ul>
6 Year w/ 50% staffing in FS1	<ul style="list-style-type: none"> <li>• Similar to and back-up to A1</li> <li>• USAP operations limited in FY22 but return to normal for FY23, &amp; FY24 field seasons</li> <li>• Assumes additional quarantine labor expenditures in US/CHC/McM</li> <li>• Schedule similar to 6-year project but with tasking reduced in the FY22 field seasons by 60% and increased in FY23 by the same amount</li> <li>• Intra/intercontinental cargo movements resume though on-ice shipping delays are anticipated</li> <li>• Overland cargo movements resume at moderate pace in FY22 – cargo backlog moved from McMurdo to Pole &amp; USAP vessel sails</li> <li>• South Pole bedspace available in FY22 to support 4 team members, FY23 18-20 and in FY24 30-32 installation team members</li> <li>• Fuel available at the South Pole to support drilling in FY24</li> </ul>
Gap year	<ul style="list-style-type: none"> <li>• Plan follows the baseline plan assuming installation at a later date</li> <li>• FY23, FY25, &amp; FY26 field seasons unrestricted</li> <li>• Minimal level of PMO and L2 management needs to be assumed in order to allow project to ‘come back’ online</li> <li>• EHWD refit activities are to be completed as much as possible in the, single, FY23 field season and the <u>drill winterized and stored</u></li> <li>• Production and procurement of necessary components is completed with items held at point of origin</li> <li>• 2 additional field seasons occur later; 1 year for SES set-up, drill integration and testing with 2<sup>nd</sup> field season for installation</li> <li>• South Pole bedspace available in FY23 to support 18 - 20 team members, FY25 to support 18-20 and in FY26 to support 30-32 installation team members</li> <li>• Fuel available at the South Pole to support drilling in FY26</li> </ul>
No Drill	<ul style="list-style-type: none"> <li>• This plan follows the baseline plan and assumes that there is no FY22 field season and no additional funds are available to complete the project</li> <li>• Major scope change will be that no drilling or installation will take place</li> <li>• EHWD refit activities are to be completed as much as possible in the, single, FY23 field season and the <u>drill prepared for long-term storage</u></li> <li>• South Pole bedspace available in FY23 to support 18 - 20 team members</li> <li>• Production and procurement of necessary components is completed with items held at point of origin</li> </ul>

# Comparison to Baseline: Scenario baseline & 7-Year Field Activities

PY3 (FY21)	PY4 (FY22)	PY5 (FY23)	PY6 (FY24)	PY7 (FY25)
<p><b>Baseline</b></p> <ul style="list-style-type: none"> <li>Vessel and overland cargo movements</li> <li>Hardening of drill pad and new ICL road</li> <li>Temp. drill testing site set-up for integration</li> <li>Majority of system repair/upgrades accomplished</li> <li>7 surface cables installed</li> </ul> <p>Staff: 8</p>	<p><b>Baseline</b></p> <ul style="list-style-type: none"> <li>SES site set-up</li> <li>Upgrade and repairs completed</li> <li>SBJ and cabling installed</li> <li>Firm drilling of 8 holes accomplished</li> <li>Partial system wet-test Rodwell established</li> <li>Hose installed on hose reel and overwintered</li> <li>Sensors (2 strings) arrive to Pole</li> </ul> <p>Staff: 15</p>	<p><b>Baseline</b></p> <ul style="list-style-type: none"> <li>SES site reestablished</li> <li>Rodwell reestablished</li> <li>Remaining sensors arrive early in season</li> <li>Drilling/instrumenting activities commence Downhole main cable connected to SJB x 7</li> </ul> <p>Staff: 30</p>	<p><b>Science Outcome</b></p>	<p><b>Science Outcome</b></p>
<p><b>6 year</b></p> <ul style="list-style-type: none"> <li>ASC - Hardening of drill pad and new ICL road, evaluating winter storage site options, &amp; drill train drift removal</li> </ul> <p>Staff: 0</p>	<p><b>6 year</b></p> <ul style="list-style-type: none"> <li>Final hardening of drill pad and new ICL road</li> <li><b>Expedited cargo reposition</b></li> <li>CRREL GPR trench routes and hole locations</li> <li>Begin at Cryo → SES set-up</li> <li>EHWD system repair/upgrades</li> <li>SES site set-up by seasons end</li> </ul> <p>Staff: 8-10</p>	<p><b>6 year</b></p> <ul style="list-style-type: none"> <li>SES de-winterization</li> <li>Generator repairs - subcontract</li> <li>Upgrade and repairs completed</li> <li>Firm drilling of (8 holes)</li> <li>Surface cables installed</li> <li>Rodwell established</li> <li>Partial system wet-test</li> <li>Drill Hose &amp; heating system installed</li> <li>Sensors (2 strings) arrive to Pole</li> </ul> <p>Staff: 14-16</p>	<p><b>6 year</b></p> <ul style="list-style-type: none"> <li>SES site reestablished</li> <li>Rodwell reestablished</li> <li>Remaining sensors/cables arrive</li> <li>Installation activities commence</li> <li>Downhole main cable connected to SJB x 7</li> <li>Drill shutdown and retrograde activities</li> </ul> <p>Staff: 30-32</p>	<p><b>Science Outcome</b></p>
<p><b>7 year</b></p> <ul style="list-style-type: none"> <li>Hardening of drill pad and new ICL road, evaluating winter storage site options, &amp; drill train drift removal</li> </ul> <p>Staff: 0</p>	<p><b>7 year</b></p> <ul style="list-style-type: none"> <li>Continue hardening of drill pad and new ICL road &amp; drill train drift removal</li> <li>Possible sub-contractor assisted gen repairs?</li> <li>Cargo reposition</li> </ul> <p>Staff: 0</p>	<p><b>7 year</b></p> <ul style="list-style-type: none"> <li>Final hardening of drill pad and new ICL road</li> <li>Cargo reposition</li> <li>CRREL GPR trench routes and hole locations</li> <li>Begin at Cryo → SES set-up</li> <li>EHWD system repair/upgrades</li> <li>SES site set-up by seasons end</li> </ul> <p>Staff: 8-10</p>	<p><b>7 year</b></p> <ul style="list-style-type: none"> <li>SES de-winterization</li> <li>Generator repairs - subcontract</li> <li>Upgrade and repairs completed</li> <li>Firm drilling of (8 holes)</li> <li>Surface cables installed</li> <li>Rodwell established</li> <li>Partial system wet-test</li> <li>Hose &amp; heating system installed</li> <li>Sensors (2 strings) arrive to Pole</li> </ul> <p>Staff: 14-16</p>	<p><b>7 year</b></p> <ul style="list-style-type: none"> <li>SES site reestablished</li> <li>Rodwell reestablished</li> <li>Remaining sensors/cables arrive</li> <li>Installation activities commence</li> <li>Downhole main cable connected to SJB x 7</li> <li>Drill shutdown and retrograde activities</li> </ul> <p><b>Science Outcome</b></p> <p>Staff: 30-32</p>

# Seasonal Equipment Site (SES) Layout



**Note: SES set-up is a substantial effort that must be accomplished the season before drilling**



- Key difference between plans are:
  - Off-ice production rate
  - Level of risk
  - Continuity/momentum/attrition potential
  - South Pole Station population profiles
  - Level of USAP contractor support
  - Transportation & logistics tempos
  - Cost
- We can plan around a wide variety of constraints, we just need to know what they are

