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| Traveler Title | LCLS HE Production Cryomodule Assembly Traveler Cold Mass Phase 2 (WS3) | | | |
| Traveler Abstract | This traveler details the assembly and in-process quality control inspections of the LCLS HE Cold Mass Phase 2. All work will be completed in the Cryomodule Assembly areas and performed by authorized and trained personnel. The scope of work begins with a completed Cold Mass Phase 1 under the 4 poster and ends with an assembly ready to move onto the Vacuum Vessel Insertion work center WS4.  Work shall be performed by trained Technical Staff.  Linked documents within the Traveler are for Reference Only, user to verify work is done to the latest revisions. | | | |
| Traveler ID | L2HE-CMA-CM-ASSY2 | | | |
| Traveler Revision | R3 | | | |
| Traveler Author | John Fischer | | | |
| Traveler Date | 2-Nov-23 | | | |
| NCR Informative Emails | adamg,jjcamp | | | |
| NCR Dispositioners | fischer,areilly,cheng | | | |
| D3 Emails | adamg,jjcamp,fischer,areilly,cheng | | | |
| Approval Names | J. Fischer | G. Cheng | A. Reilly | A. Grabowski |
| Approval Signatures |  |  |  |  |
| Approval Dates |  |  |  |  |
| Approval Title | Author/Group Lead | Project Engineer | SRF Dept Head | Project Representative |

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| References | List and Hyperlink all documents related to this traveler. This includes, but is not limited to: safety (THAs, SOPs, etc), drawings, procedures, and facility related documents. | | | |
| [F10127865\_E\_Cavity String](https://misportal.jlab.org/jlabDocs/documents/versions/185834/download) | [F10009375-U-Magnet Assy](https://misportal.jlab.org/jlabDocs/documents/versions/185835/download) | [F10048652-G-Magnetic Shielding Dwg](https://misportal.jlab.org/jlabDocs/documents/versions/185841/download) | [F10127864\_B\_Cold Mass Assy](https://misportal.jlab.org/jlabDocs/documents/versions/184613/download) | [F10151272-A-Magnetic Shielding Cav 1](https://misportal.jlab.org/jlabDocs/documents/versions/185842/download) |
| [F10151275-A-Magnetic Shielding Cav 6](https://misportal.jlab.org/jlabDocs/documents/versions/185843/download) | [11141S0029-2e-10 Leak Check Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257482/11141S0029%202e-10%20Leak%20Check%20Final.pdf) | [11141S0033-1e9 Leak Check Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257481/11141S0033%201e9%20Leak%20Check%20Final.pdf) | [Cavity Alignment Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257483/Cavity%20alignment%20procedure.docx) | [F10009954\_V\_Upper Cold Mass Dwg](https://misportal.jlab.org/jlabDocs/documents/versions/185917/download) |
| [F10017613\_E\_50K Shields Dwg](https://misportal.jlab.org/jlabDocs/documents/versions/184924/download) | [F10040841\_G\_2K Clamp Magnet](https://misportal.jlab.org/jlabDocs/documents/versions/185848/download) | [F10045236\_J\_5K Clamp Magnet](https://misportal.jlab.org/jlabDocs/documents/versions/185920/download) | [F10046443\_F\_50K Clamp Magnet](https://misportal.jlab.org/jlabDocs/documents/versions/185849/download) | [F10127855\_A\_L2HE CM Assy](https://misportal.jlab.org/jlabDocs/documents/versions/184612/download) |
| [L2HE-CMA-UCM-DMAG-R1](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-243879/L2HE-CMA-UCM-DMAG-R1.pdf) | [L2HE-CMA-UCM-INSP-R1](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-244132/L2HE-CMA-UCM-INSP-R1.pdf) | [JLab Tuner Installation Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-125846/JLab%20Tuner%20Installation%20Procedure%20082916.docx) | [LCLSHE Limit Setting Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257488/LCLS%20II%20HE%20LS%20setting%20procedure_V1.pdf) |  | |

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| Revision Note |  |
| R1 | Initial release of this Traveler. |
| R2 | Correct SN acronyms for this project versus L2PRD. Revised NCR/D3 usernames and approval names. |
| R3 | Added to abstract, some steps changed to better align with assembly sequencing. Steps also moved out of this Traveler to WS4 to align assembly durations. |

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| Step No. | Instructions | Data Input |
| 1 | Record the Cavity String and UCM SN's  **\*\*Note: The LCLS Cryomodule assembly has many vulnerable components. Bellows in every vacuum circuit and process piping, feedthrus for the HOM's and Field Probe, and multiple interference points. \*\*** | [[Record\_SRF]] <<SRF>>  [[RecordTime]] <<TIMESTAMP>>  [[CMSN]] <<CMSN>>  [[UCMSN]] <<UCMSN>> |
| 2 | Is the Cold Mass Phase 1 Traveler Complete? | [[CMP1Comp\_SRF]] <<SRF>>  [[CMP1CompDate]] <<TIMESTAMP>>  [[CMP1CompYesNo]] <<YESNO>>  [[CMP1CompComm]] <<COMMENT>> |
| 3 | Use the WS3 Fastener Spreadsheet and sign off as the work is completed. It will be uploaded to the Traveler once finished.  [Check list for WS3 fasteners](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-155014/Workstation%203%20sign%20off-1.pdf) | [[WS3SRF]] <<SRFCMP>>  [[WS3Date]] <<TIMESTAMP>>  [[WS3Comm]] <<COMMENT>> |
| 4 | Install the UCM Assembly onto the 4 poster fixture. Use [8K Lift Plan](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-136441/8%2c000lb%20spreader%20bar%20lift%20plan.pdf) to complete this lift.  **\*\*\* Note - This crane lift can be done by Authorized Technicians only.\*\*\*** | [[UCMAssyTech]] <<SRF>>  [[UCMAssyDate]] <<TIMESTAMP>>  [[UCMAssyComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 5 | Perform the required QC and Demagnetization of the UCM Assembly and parts.   * Measure and demagnetize the bearing block assemblies, gate valve bracket, split rings, invar rods, and tuners. * Alignment crew to perform dimensional inspection. * Leak check cryogenic lines A, D, and F. Record results. * CWI to perform weld Inspection   The attached Travelers are for reference.  [L2HE-CMA-UCM-INSP-R2](https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-56156)  [L2HE-CMA-UCM-DMAG-R1](https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-51581)  [L2HE-CWI-UCM-R2](https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-56158) | [[QC\_SRF]] <<SRF>>  [[QCDate]] <<TIMESTAMP>>  [[QCComm]] <<COMMENT>>  [[UCMQCResults]] <<FILEUPLOAD>>  [[SmallPartDemagComplete]] <<YESNO>> |
| 6 | Complete the warm up cooldown heater assy. Use the Fastener Spread Sheet as a guide when reassembling.  **\*\*\*Note- Only trained Electrical Technicians are to perform this step.\*\*\*** | [[ElecTech]] <<SRF>>  [[ElecDate]] <<TIMESTAMP>>  [[ElecComm]] <<COMMENT>> |
| 7 | Raise the UCM to provide proper clearance, slowly move the Cavity string under the 4 poster watching for interferences.  **New to L2HE is the neg pump assembly on the magnet end, shown in the below view. Exercise caution around this manifold.**  Verify the "Z" locations of the Cavity String, Magnet, and Gate Valves. Use a plumb bob to the cavity 5 cold coupler CL, fine tune as needed prior to lowering the UCM. **\*\*\*Note- Only trained Technicians can lead the transfer of the Cavity string under the UCM. A minimum of 6 people needed during this move.\*\*\*** | [[UCMRaiseTech]] <<SRF>>  [[UCMRaiseDate]] <<TIMESTAMP>>  [[UCMRaiseComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 8 | Install the plastic spacer blocks on top of the HV and Magnet support lugs. Slowly lower the GHRP until you have contacted any one spacer.Monitor the move, making sure no weight is not put onto the cavity string and verify that there are no interferences. GHRP Hanger Pads should be in the proper relationship to the helium vessel lugs.    **\*\*\*Note- Only trained Technicians can lead the lowering of the UCM to the Cavity String. A minimum of 6 people needed during this move.\*\*\*** | [[GHRP\_SRF]] <<SRF>>  [[GHRPDate]] <<TIMESTAMP>>  [[GHRPComm]] <<COMMENT>> |
| 9 | Prepare the magnet assembly by verifying the leveling feet are supporting the magnet weight, then remove the lug clamps and fixture sidewalls. If necessary, fine tune the HV/Magnet lug to hanger dimension as required to accommodate the bearing block installation. This is achieved by carefully adjusting the lollipop tooling.  **\*\*\*Note- Only trained Technicians will perform this step due to the need to maintain proper alignment and bellows positioning.\*\*\*** | [[MagAssy\_SRF]] <<SRF>>  [[MagAssyDate]] <<TIMESTAMP>>  [[MagAssyComm]] <<COMMENT>> |
| 10 | Install the previously demagnetized needle bearing support assemblies onto the HV and Magnet lugs, snug all adjustment hardware to 20 in/lbs. Verify the installation, being sure the ladder bearings are properly positioned, then add the Stop Plates to each bearing assy. | [[Needle\_SRF]] <<SRF>>  [[NeedleDate]] <<TIMESTAMP>>  [[NeedleComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 11 | Install the Cavity 1 Extended Tuner using the attached Procedure and Fastener Spread sheet. This assembly is to be demagnetized before installation. [L2HE Extended Tuner Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-278756/L2HE%20extended%20tuner%20procedure.docx)  **\*\*\*Note- Only trained Technicians will perform this step due to the need to maintain proper alignment and bellows positioning.\*\*\*** | [[ExtTuneTech]] <<SRF>>  [[ExtTuneDate]] <<TIMESTAMP>>  [[ExtTuneComm]] <<COMMENT>> |
| 12 | Loosely install the 8 HV post and verify the 2 center invar clamps are tight. The center clamps will lock the position of the invar rod, be sure to install them tightly touching the center GHRP support structure. Cavity 1 thru 8 clamps are 22mm wide and the Magnet clamp is 20mm wide and includes the anti- roll flanges. Install in the correct position. | [[HVPost\_SRF]] <<SRF>>  [[HVPostDate]]  <<TIMESTAMP>>  [[HVPostComm]] <<COMMENT>> |
| 13 | Install the gate valve bracket on the Down Stream end. Follow the Fastener Spread Sheet to complete this work. | [[ValveBrack\_SRF]] <<SRF>>  [[ValveBrackDate]] <<TIMESTAMP>>  [[ValveBrackComm]] <<COMMENT>> |
| 14 | Technical Lead to verfiy all bearing block assemblies, cavity 1 tuner, and downstream gate valve hanger have been assembled correctly and torqued.  \*\***All items supporting the cavity string must be verified prior to removing the lollipop tooling\*\*** | [[Verify\_SRF]] <<SRF>>  [[VerifyDate]] <<TIMESTAMP>>  [[VerifyComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 15 | Remove the magnet tooling in preparation of the Magnet Lead soldering. | [[MagToolRmvSRF]] <<SRF>>  [[MagToolRmvDate]] <<TIMESTAMP>>  [[MagToolRmvComm]] <<COMMENT>> |
| 16 | Lower the cavity tooling lollipops and return to cleanroom  Care should be taken when lowering the tooling that cavity is not caught.  **\*\*\*Note- Only trained Technicians are to perform this step due to the need to maintain proper alignment and bellows positioning.\*\*\*** | [[Tooling\_SRF]] <<SRF>>  [[ToolingDate]] <<TIMESTAMP>>  [[ToolingComm]] <<COMMENT>> |
| 17 | Weld the process piping [F10127864\_B\_Coldmass Assembly](https://misportal.jlab.org/jlabDocs/documents/185033/download)   * ¼” line couplings * GHRP tee additions * 2 phase cap discs * Remaining invar support rings   Complete the In-Process weld examinations. Upload results.  **\*\*All lower fill lines to be as tight to the helium vessel bottoms as reasonable to allow room for shields and minimize thermal shorts\*\*** | [[WelderSRF]] <<SRF>>  [[WelderDate]] <<TIMESTAMP>>  [[WelderComm]] <<COMMENT>>  [[WelderDocumentation]] <<FILEUPLOAD>> |
| 18 | Prep then Solder the magnet current leads and install into thermal clamps. Torque clamp hardware to 50 ft/lbs, use [F10040841\_Rev-G 2k Magnet Lead Clamp](https://misportal.jlab.org/jlabDocs/documents/versions/185848/download), [F10045236\_Rev-H 5K Magnet Lead Clamp](https://misportal.jlab.org/jlabDocs/documents/versions/185920/download), [F10046443 Rev-F 50K Magnet Lead Clamp](https://misportal.jlab.org/jlabDocs/documents/versions/185849/download).  **\*\*\*Note- Only trained Electrical Technicians are to perform this step.\*\*\*** | [[MagSolderTech]] <<SRF>>  [[MagSolderDate]] <<TIMESTAMP>>  [[MagSolderComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 19 | Install the 2 phase invar rods and GHRP 2 phase clamps (3 x's) | [[InvarRodInstSRF]] <<SRF>>  [[InvarRodInstDate]] <<TIMESTAMP>>  [[InvarRodInstComm]] <<COMMENT>> |
| 20 | Install the aluminum GHRP testing caps. **Use the installation cart to protect the beamline during the operation.**  GHRP pipe ends may be out of round  **\*\*\*Note- Only trained Technicians are to perform this step.\*\*\*** | [[GHRPTestCapSRF]] <<SRF>>  [[GHRPTestCapDate]] <<TIMESTAMP>>  [[GHRPTestCapComm]] <<COMMENT>> |
| 21 | Leak check the 2 phase circuit.   * Out board bellows restraints must be in place prior to process piping evacuation. * Siphon tubes end must be blanked off * He supply lines blanked * GHRP Testing caps in place   Upload findings.  [11141S0033-Large Leak Check Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257481/11141S0033%201e9%20Leak%20Check%20Final.pdf)  **\*\*\*Note- Only Leak Detection trained Technicians are to perform this step.\*\*\*** | [[LkChck2PSRF]] <<SRF>>  [[LkChck2PDate]] <<TIMESTAMP>>  [[LkChck2PComm]] <<COMMENT>>  [[LkChck2PFile]] <<FILEUPLOAD>> |
| 22 | Once piping is bled up, remove all leak checking blank off materials listed above. Cover openings | [[LkChSRF]] <<SRF>>  [[LkChDate]] <<TIMESTAMP>>  [[LkChComm]] <<COMMENT>> |
| 23 | Align the cavity string, record findings. [Cryomodule Group Alignment Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-278643/L2HE%20Cryomodule%20CS2UCM%20Alignment%20Procedure_SRFCMA%20JLAB%20Template.docx), [JLAB Align Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-278644/L2HE%20Cryomodule%20CS2UCM%20Alignment%20Procedure_JLAB%20Template.docx)  Bearing block stop plates should be removed once HV invar clamps are tightened and alignment is completed. Cavity 5 is fixed with a variation of stop plate.  Add Loctite 290 to screws on HV invar clamps after alignment is complete.  **\*\*\*Note- Only trained Technicians are to perform this step.\*\*\*** | [[AlignmentSRF]] <<SRF>>  [[AlignmentDate]] <<TIMESTAMP>>  [[AlignmentComm]] <<COMMENT>>  [[AlignmentData]] <<FILEUPLOAD>>  [[AlignHold]] {{fischer,jared,jjcamp }} <<HOLDPOINT>> |

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| Step No. | Instructions | Data Input |
| 24 | Continue installation of the 2nd layer magnetic shields.  This will add the center section and beam pipe halves prior to tuners, protect the wires during shield installation, edges may be sharp.  [Magnetic Shield Installation Procedure-Rev 8](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-125847/464267%20Magnetic%20Shielding_V8.pdf) | [[MagShldSRF]] <<SRF>>  [[MagShldDate]] <<TIMESTAMP>>  [[MagShldComm]] <<COMMENT>> |
| 25 | Install the remaining instrumentation onto the Cold Mass Assembly. This will include process piping and shield thermal sensors, and magnet voltage taps.  **\*\*\*Note- Only trained Electrical Technicians are to perform this step.\*\*\*** | [[CMAInstSRF]] <<SRF>>  [[CMAInstDate]] <<TIMESTAMP>>  [[CMAInstComm]] <<COMMENT>> |
| 26 | Install the tuners,stepper motors, and piezos. **Note-The Bellows Braces and Split rings must be removed with care. Use the following documents to execute the work.** [JLAB Tuner Installation Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-125846/JLab%20Tuner%20Installation%20Procedure%20082916.docx), [Limit Switch Setting Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-257488/LCLS%20II%20HE%20LS%20setting%20procedure_V1.pdf), [914269-Bellows Brace Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-165777/914269-Bellow%20Brace%20Procedure.docx)  Perform tuner and piezo functionality tests  Apply preload. Record setup information  **\*\*\*Note- Only qualified Technicians are to perform this step. Work is in very close proximetry to the Helium Vessel and Beam Pipe Bellows.\*\*\***    **SM – Stepper Motors**  **TUNW –Tuners**  **PIEZOS - Piezos** | [[TuneStepPiezosInstSRF]] <<SRF>>  [[TuneStepPiezosInstDate]] <<TIMESTAMP>>  [[TuneStepPiezosInstComm]] <<COMMENT>>  [[TunerDataUpload]] <<FILEUPLOAD>>  [[TuneReviewLeadSRF]] <<SRF>>  [[SMSNCAV1]] <<SMSN>>  [[SMSNCAV2]] <<SMSN>>  [[SMSNCAV3]] <<SMSN>>  [[SMSNCAV4]] <<SMSN>>  [[SMSNCAV5]] <<SMSN>>  [[SMSNCAV6]] <<SMSN>>  [[SMSNCAV7]] <<SMSN>>  [[SMSNCAV8]] <<SMSN>>  [[PIEZOSNUpperCav1]] <<PIEZOSN>>  [[PIEZOSNLowerCav1]] <<PIEZOSN>>  [[PIEZOSNUpperCav2]] <<PIEZOSN>>  [[PIEZOSNLowerCav2]] <<PIEZOSN>>  [[PIEZOSNUpperCav3]] <<PIEZOSN>>  [[PIEZOSNLowerCav3]] <<PIEZOSN>>  [[PIEZOSNUpperCav4]] <<PIEZOSN>>  [[PIEZOSNLowerCav4]] <<PIEZOSN>>  [[PIEZOSNUpperCav5]] <<PIEZOSN>>  [[PIEZOSNLowerCav5]] <<PIEZOSN>>  [[PIEZOSNUpperCav6]] <<PIEZOSN>>  [[PIEZOSNLowerCav6]] <<PIEZOSN>>  [[PIEZOSNUpperCav7]] <<PIEZOSN>>  [[PIEZOSNLowerCav7]] <<PIEZOSN>>  [[PIEZOSNUpperCav8]] <<PIEZOSN>>  [[PIEZOSNLowerCav8]] <<PIEZOSN>>  [[TUNCXSNCAV1]] <<TUNXCSN>>  [[TUNCXSNCAV2]] <<TUNXCSN>>  [[TUNCXSNCAV3]] <<TUNXCSN>>  [[TUNCXSNCAV4]] <<TUNXCSN>>  [[TUNCXSNCAV5]] <<TUNXCSN>>  [[TUNCXSNCAV6]] <<TUNXCSN>>  [[TUNCXSNCAV7]] <<TUNXCSN>>  [[TUNCXSNCAV8]] <<TUNXCSN>> |

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| Step No. | Instructions | Data Input |
| 27 | Install the remaining interconnect magnetic shielding and HV end caps. Be sure to keep serial numbers aligned. [Magnetic Shield Installation Procedure-Rev 8](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-125847/464267%20Magnetic%20Shielding_V8.pdf)  **\*\*\*Note- Only qualified Technicians are to perform this step. Work is in very close proximetry to the Helium Vessel and Beam Pipe Bellows.\*\*\*** | [[RemMagShldInstSRF]] <<SRF>>  [[RemMagShldInstDate]] <<TIMESTAMP>>  [[RemMagShldInstComm]] <<COMMENT>> |
| 28 | Install the thermal strapping to include stepper motors, HOM's, and cold coupler 5k and 50 k intercepts. Multi strand Cu straps should have shrink Mylar in place prior. Indium foil, bellevilles, or lock-tite shall be included as defined in- [Fastener Installation and Torque Chart](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-125853/Copy%20of%20Fastener%20Summary-1%203CM_20160621.xlsx) | [[ThermInstSRF]] <<SRF>>  [[ThermInstDate]] <<TIMESTAMP>>  [[ThermInstComm]] <<COMMENT>>  [[Complete50K]] <<CHECKBOX>>  [[Complete5K]] <<CHECKBOX>>  [[HOMComplete]] <<CHECKBOX>>  [[StepperMotorComplete]] <<CHECKBOX>>  [[ThermStrapReview]] {{fischer,jjcamp,jared}} <<HOLDPOINT>> |

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| Step No. | Instructions | Data Input |
| 29 | Complete the 2k MLI and Kapton isolation   * Add Kapton isolation around the magnet thermal intercept clamps * Install 2K MLI on the remaining cold surfaces; magnet intercepts, and magnet body | [[MLICompSRF]] <<SRF>>  [[MLICompDate]] <<TIMESTAMP>>  [[MLICompComm]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 30 | Upload the completed [Check list for WS3 fasteners](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-155014/Workstation%203%20sign%20off-1.pdf). Note any deviations. | [[ChecklistUploadSRF]] <<SRFCMP>>  [[ChecklistUploadDate]] <<TIMESTAMP>>  [[ChecklistUploadComm]] <<COMMENT>>  [[FastenerSheet]] <<FILEUPLOAD>> |
| 31 | Review the WS3 work is complete using the Checklist, upload finding,  Cold Mass Phase 2 assembly is complete, ready for Vacuum Vessel. | [[TravCompSRF]] <<SRF>>  [[TravCompDate]] <<TIMESTAMP>>  [[TravCompComm]] <<COMMENT>>  [[TravelerComplete]] {{fischer,jjcamp,jared}} <<HOLDPOINT>>  [[WS3Checklist]] <<FILEUPLOAD>> |