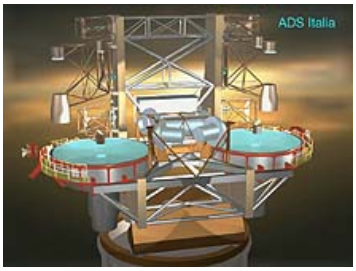

LBT PROJECT
2x8,4m TELESCOPE

Doc.No. : 580s006
Issue : c
Date : 01-Mar-07

LBT PROJECT

2 X 8,4m OPTICAL TELESCOPE

LBT Dynamic Balancing System

Requirements Review Items

1. Revision History

Issue	Date	Changes	Responsible
a	20-Jan-07	First issue Review items to Design Team	Joar Brynnel Review Team
b	15-Feb-07	Dynamic Balancing Team Replies	V. Gasho, B. Cuerden, J. Noenickx, J. Rill
c	01-Mar-07	Update team replies based on 16-Feb-07 meeting.	V. Gasho

2. Table Of Contents

3. About this document

3.1. Purpose

This document summarizes comments and questions submitted during review of the document “LBT Dynamic Balancing System – System Requirements and Specifications” [RD1].

3.2. About this document

The document under review, [RD1], is a specification document for the development of a “Dynamic Balancing System” for the Large Binocular Telescope LBT. The document was produced by the Dynamic Balancing System design team under the supervision of Victor Gasho, Steward Observatory, for the LBT.

The review team:

- John Hill, LBT Technical Director
- Dave Ashby, LBT Systems Engineer
- John Little, LBT Site Lead Engineer
- Mike Gusick, LBT Electronics Engineer
- Jonathan Kern, LBT Mechanical and Commissioning Lead Engineer
- Joar Brynnel, LBT Engineering Manager

3.3. How to read this document

Comments and questions from the review team are listed in section 4 of this document. Each review item is listed with name of the originator, reference to the relevant section of [RD1], and a line for the reply of the design team. The design team can accept the review item (A) with or without comment, reject the review item (R) with a motivation, or request clarification (C). Similar comments from two or more reviewers have been grouped together in one review item.

Based on the meeting that occurred February 16, 2007, between the design team and LBT Engineering, some of the team replies have been revised. The revised replies appear below the original reply.

3.4. Reference Documents

[RD1] 580s005 LBT Dynamic Balancing System – System Requirements and Specifications, Rev. A

4. Review Items

4.1. Wording

Initiator	Kern
Location (Section)	4.1
Comment	Replace word “antenna” with “telescope”
Reply (A/R/C)	*A*

4.2. Time for Rebalancing

Initiator	Kern
Location (Section)	6.1
Comment	1 Hour: We really need to think hard about this time. Do we have enough swing arm experience to establish a time to balance at this point? 1hr seem awfully long.
Initiator	Little
Location (Section)	6.1
Comment	1 Hour: way to long! Should not exceed 5 minutes.
Initiator	Ashby
Location (Section)	6.1
Comment	1 hr is too long. It takes about 4.5 minutes to deploy or retract a swing arm. I think the dynamic balance system should be able to move 2000 kg from one y-tank to the other in this same period of time. I don’t know what the pumps are rated for but I would expect a 480VAC pump should have sufficient capacity..
Initiator	J. Hill
Location (Section)	6.1
Comment	I'm expecting that the time to rebalance should be 15 minutes or less. So that a whole configuration change can be done in ~30 minutes: ~ 5min slew to zenith and insert stow pins ~ 5 min retract swing arms ~ 5 min move new swing arms in ~10 minutes to balance ~ 5 minutes back to tracking mode ~ 5 min MCSPU balance run? (maybe 40 min if more than 2 pairs of swing arms have to be moved)

Reply (A/R/C)	*C – The 1 hour time period assumed that we would need to move the full 6000 liters of fluid from one Y-axis tank to the other. The full 6000 liters is needed for all swing arms retracted or deployed. This is not a typical case.* *If it is desired to have just 2000l pumped from one tank to the other it should be possible to do so in 10 minutes with a pump capacity at 200 l/min. The current pump will handle this, but it will still take 30 minutes to pump the full 6000l.* *In addition the pumping can occur in parallel with the swing arm change to reduce the time for the operation. So, in John's scenario the pumping can start immediately when the stow pins are inserted and the whole operation can be completed in 15 minutes.* *LBT should let us know if all of this is acceptable.*
Revised Reply (A/R/C)	*A- It was decided at the meeting to make the requirement for the fluid transfer rate to be 200 liters/min. Therefore it will take 10 minutes to transfer 2000 liters, or 2000 kg, of fluid to the tanks. It will still take 30 minutes to transfer the full 6000 liters in the y-axis system and 15 minutes to pump the full 3000 liters in the z-axis system.*

4.3. Metrology

Initiator	Kern
Location (Section)	6.1
Comment	Text "degraded performance": Cannot mass transfer be measured in another way? What about mass flowmeters?
Reply (A/R/C)	*R- Since mass flowmeters can only measure accurate flow in one direction we would need one for each flow direction, two for each system, or add extra valving and pump in only one direction. We feel this makes the system more complicated and adds expense.* *It is also team's recommendation that the system should only be used at zenith pointing and rely on the pumps to do the primary metering. Any other sensor, flowmeter and/or level sensor, should only be used as a secondary check.*
Revised Reply (A/R/C)	*A- Mass flowmeters will be investigated by the team for use as the primary sensor for the system. The system will only be used at zenith.*

4.4. Vibrations

Initiator	Kern
Location (Section)	6.3
Comment	Text “degrade the performance”: What does this mean? Maybe this is the only way to express the intent but I'd prefer to see a frequency/energy upper limit. Can we get a maximum injected moment from Dave?
Reply (A/R/C)	*C – Yes can LBT provide those values? Or is it 100 Nm at 1.5 Hz?*
Revised Reply (A/R/C)	*A- The specification will be that the structural resonances of the system will be higher than 10Hz. In addition the specification for sloshing will be the following “For sloshing disturbance torque, the requirement is that after waiting 5 seconds after a slew the disturbance due to sloshing, must be less than 100 Nm at and below 1.5 Hz, and rolloff in amplitude 20dB for every decade of frequency above 1.5 Hz.”*

4.5. Level Sensors

Initiator	Kern
Location (Section)	6.5
Comment	Text “six liquid level sensors”: This is the only place in the document where level sensors are mentioned. I don't know of any way to use a single sensor in a rotating tank, two in each tank will be required, knowing elevation to calculate liquid level. I frankly think this is the wrong approach, I would use accurate metering pumps to transfer know amounts and log transferred masses between balancing.. At periodic intervals I would normalize the system by draining everything to the low tank.
Reply (A/R/C)	*C - The liquid level sensors can only be used with the telescope at zenith. The pumps already procured are positive displacement pumps and they will be run a known amount of time or revolutions (TBD) to move the desired volume of fluid, which will be double checked against the level change in the tanks. This level change is determined by the level sensor being read at zenith.* *Metering pumps are an alternative, but we have been unable to find metering pumps with sufficient flow at this point.*
Revised Reply (A/R/C)	*C- In the second sentence of the original reply, the pump run time or counting revolutions will be replaced by using a flowmeter as the primary sensor for determining the amount of fluid transferred. The rest of the original reply is valid.*

4.6. Mass Sensors

Initiator	Kern
Location (Section)	6.5
Comment	Text “mass of water in each tank”: I think they mean "mass of water transferred into each tank".
Reply (A/R/C)	*A – There are no mass sensors in the system and this line shall be deleted.*

4.7. Accuracy

Initiator	Kern
Location (Section)	6.5
Comment	Text “The sensors shall have an ability to measure the mass of water to within an accuracy of +/-2.5 kg.” How was the 2.5kg value determined?
Reply (A/R/C)	*C – This value was derived from the desire to have a resolution of the system to be 10% of the tolerance. The tolerance is 5000 Nm, so we wanted to resolve 500 Nm. To have this you need to know the level in the top vertical tank to within 5 liters (5 kg) or have an accuracy of +/- 5 kg (not the +/-2.5 stated in the document). We have rethought this point and feel that this value can be raised to 3500 Nm or a resolution of 50% rss of the tolerance. This relaxes the requirement to being able to resolve 35 kg (35 l) or +/- 35kg in the upper vertical tank.*
Revised Reply (A/R/C)	*C- The last sentence of the original reply is now changed such that the metering accuracy of the system will be 0.5% with a goal of 0.1% in both systems.*

4.8. Pumps

Initiator	Kern
Location (Section)	7.1.1.
Comment	I would think carefully about using displacement pumps and mass flow meters, as opposed to metering style pumps. It is not clear to me that one is better than the other, only that a metering pump simplifies the system. In either event, uncertainties will accumulate and they system will need to be normalized by making sure all the liquid is in one place.
Reply (A/R/C)	*R – With the flow rates required we have been unable to find metering pumps with the required flow rate. We do have positive displacement pumps already and if they can do the job we should use them.* *The level sensors should be able to assist in normalizing the system if needed on a periodic basis, since they will be able to accurately determine whether a tank is at its capacity. Below capacity when the fluid is moving the level sensors will be less accurate, but we believe accurate enough to give us a secondary check on the amount of fluid that has been pumped. This can be accomplished by taking a difference between the before and after levels.*

4.9. Pump Capacity

Initiator	Kern
Location (Section)	7.1.1
Comment	I assume pump capacity is a value that flows down from some time-to-balance number?
Reply (A/R/C)	*A – Yes this flows down from the 1 hour time to rebalance which will be changed to 30 minutes. Therefore this number will go from 100 l/min to 200 l/min.*

4.10. Clarification

Initiator	Little
Location (Section)	6.1
Comment	Add clarification text: Primary z-axis operation will be at horizon
Reply (A/R/C)	*R – We do not believe that the z-axis system must be used at horizon and can be used at zenith reliably. To simplify things we also suggest that the z-axis system should only be used at zenith.*

4.11. Clarification

Initiator	Little
Location (Section)	6.5
Comment	Add clarification text to 5th bullet: "there might be a need for 3 flow sensors due to the position of the 4 z-axis tanks"
Reply (A/R/C)	*R- We have eliminated the use of flowmeters in the system.*
Revised Reply (A/R/C)	*A- We will investigate the use of mass flowmeters in the system and consider whether we need an extra one for the z-axis system.*

4.12. Pressure

Initiator	Little
Location (Section)	6.10
Comment	Storage and operating pressure must include sea level
Reply (A/R/C)	*A*

4.13. Wind speed

Initiator	Little
Location (Section)	6.10
Comment	Stated: Operational wind speed 80 kmh and Observing wind speed 120 kmh Are those numbers correct?
Reply (A/R/C)	*C – We have found that the operational wind speed is 80 km/h on the LBT webpage and the observing wind speed was copied off an early spec for the pier. Can LBT let us know what the current operational and observing wind speeds are?*
Revised Reply (A/R/C)	*C – The specification will state that 80 km/h is the observing wind speed limit and 120 km/h is the survival wind speed.*

4.14. Viscosity

Initiator	Little
Location (Section)	7.1.1.
Comment	Fluid viscosity: Note that there is a large viscosity change with temperature.
Reply (A/R/C)	*A – It looks like there is a mistake here in that at -20 C the kinetic viscosity is 20 cSt, so the document will be changed to reflect that the flow rate is specified with a fluid viscosity below 20 cSt @ -20C instead of 40 cSt @-20C. The viscosity is 3 cSt @ 20C, so roughly a change of 6 times in viscosity over the operating temperature range.*

4.15. Pumps

Initiator	Little
Location (Section)	7.1.1
Comment	A Positive displacement style pump is specified. What about using a hydronic pump?
Reply (A/R/C)	*C – The only information on hydronic pumps deal with heat pumps, so we are not sure if this applies. If this is incorrect, can you give some information on this style of pump?*

4.16. Voltage

Initiator	Little
Location (Section)	7.1.3.1
Comment	Power to automatic valves – should this be 120VAC?
Reply (A/R/C)	*R – We have determined from the wiring diagrams and nameplate that the valves are 480 VAC 3 phase.*

4.17. Piping

Initiator	Little
Location (Section)	7.1.4
Comment	Has plastic piping been considered?
Reply (A/R/C)	*A - At this point we did not consider plastic pipe, but will look at it as an alternative. The requirements leave this open as a possibility.*

4.18. Sensors

Initiator	Little
Location (Section)	7.1.6.1 (Level sensors) 7.1.7 (Flow meters)
Comment	Add environmental specification for sensors
Reply (A/R/C)	*A*

4.19. Accuracy

Initiator	Ashby
Location (Section)	General
Comment	The precision and accuracy of various components depends on the control strategy used. I think of it as an incremental rather than an absolute system. Functionally, we should be able to make a 15000 kg m (the resulting balance change by moving LBC Red in or out) adjustment with an accuracy of 50 kg m (~4 kg of fluid). This represents 0.3% flow metering accuracy. The absolute level in each tank is not required except to detect where we are in the total range.
Reply (A/R/C)	*A – In general our control strategy is to assume the pumps can deliver a constant flow rate for the period of time or number of turns (TBD) that they run. Therefore the time/turns for the pump to run is the parameter that is controlled. The pump run time/time is derived from a previously calibrated look up table for a particular swing arm configuration. The level sensors on the tanks are checked before pumping and after. The difference is used as a cross check to be sure the amount of fluid pumped is in the range of what was expected. If it passes this check, then the telescope is moved in a small range with the stow pin inserted to verify that the telescope is roughly balanced about the y-axis (as this is the axis which requires more fluid transfer for normal swing arm changes.). This is expected to be within 240 kg for a full 6000 kg transfer for the y-axis or 120 kg for a full 3000 kg transfer for the z-axis. A complete balance run is then performed and the y-axis and z-axis can be trimmed as necessary. This is expected to be within 10 kg and 5 kg for the y and z-axis trim respectively.* *Dave is correct that an incremental system will work and an absolute system is not needed.*
Revised Reply (A/R/C)	*A – The fluid metering accuracy will be 0.5% with a goal of 0.1%.*

4.20. Sloshing

Initiator	Ashby
Location (Section)	6.3
Comment	Residual axis torque due to fluid sloshing should not exceed 100 Nm. This will need to be tested at various accelerations up to 0.3 deg/sec^2.
Reply (A/R/C)	*C – We should be sure of this number before making it a hard requirement, since we have little control over the tank design at this point. Can you determine from the recent tests that we did not have 100 Nm of residual torque with the tank ~15% full?*
Revised Reply (A/R/C)	*A - The specification for sloshing will be the following "For sloshing disturbance torque, the requirement is that after waiting 5 seconds after a slew the disturbance due to sloshing, must be less than 100 Nm at and below 1.5 Hz, and rolloff in amplitude 20dB for every decade of frequency above 1.5 Hz."*

4.21. Standard components

Initiator	Ashby
Location (Section)	6.4
Comment	We should specify the PLC as an AB series 1756 ControlLogix PLC.
Reply (A/R/C)	*A*

4.22. Safety

Initiator	Ashby
Location (Section)	6.4
Comment	The system must include a lockout ability that will interrupt power to the drives.
Reply (A/R/C)	*A- We will include a compatible lockout tagout switch for the system.*

4.23. Standard components

Initiator	Gusick
Location (Section)	6.4
Comment	The TBD driver – if a VFD is used it would be good to use similar model drives (i.e. AllenBradley) that we use in many other places on the telescope.
Initiator	Ashby
Location (Section)	6.4
Comment	We will likely require a VFD for the pumps. If this is the case, we should try to utilize the AB drives used for the swing arms to minimize the types of spares we need to stock.
Reply (A/R/C)	*A- We will look at the VFD driver and make it identical to the swing arm drive if possible, assuming the time method works. Otherwise we will need a different VFD for encoder operation to implement the counting of turns method.*
Revised Reply (A/R/C)	*R- Since the flow meters will be the primary metering device and the pumps do not require sophisticated controller, we will implement a soft start control unit for the pump motors instead of the VFD,*

4.24. Mass measurement

Initiator	Ashby
Location (Section)	6.5
Comment	Please explain what you have in mind for a mass measurement.
Reply (A/R/C)	*A - This was a typo and we will delete that bullet. We will only measure fluid level in the tank to approximately determine the volume pumped is within the desired tolerance.*

4.25. Interlocks

Initiator	Ashby
Location (Section)	6.5
Comment	1) Some of this information must be communicated using discrete signaling. Not everything is available over the ControlNet. Example EStop and Interlocks. 2) EStop must be integrated into the system 3) Some of the interlocks must be implemented using discrete logic. In particular, zenith stow is detected in hardware alone. It is expected that this failsafe interlock will interrupt pump power. Please specify which interlocks will be implemented in hardware.
Reply (A/R/C)	*A- E-stops and zenith stow pin will be implemented as fail safe hardware interlocks.*

4.26. Mass measurement

Initiator	J. Hill
Location (Section)	6.5
Comment	There is a call for "mass sensors" which (except for specialized gravitometers) do not exist. This should be rephrased to account for depth sensors and/or pressure sensors which allow us to estimate the mass of liquid in the tanks.
Initiator	Ashby
Location (Section)	6.5
Comment	1) The statement that the mass of the fluid can be measured to within +/-2.5 kg seems to conflict with general requirements. Please clarify. 2) This is the first time a mass measurement has been mentioned. How do you propose to use this? How do you propose to measure this?
Reply (A/R/C)	*A – John and Dave are correct there are no mass sensors. We only use the level sensors to measure the approximate volume of liquid in the tank.* *The +/- 2.5 l should have been +/-5 l since the general requirement was to have a resolution of 500 Nm or 10% of the desired imbalance tolerance. This has changed see discussion in comment 4.7.*

4.27. Control strategy

Initiator	Ashby
Location (Section)	6.5
Comment	The dynamic balance system should integrate into the swing arm controls so that a first cut at the balance can be obtained though a lookup table. A swing arm produces a delta-Y balance that should be compensated for by the dynamic balance system automatically. An additional Y-Z trim can then be applied after a balance run is performed. The trim commands and lookup table should be calibrated in real-world units (kg m). The ability to calibrate the lookup table should be available through both the LCP and the MCSPU interface. A control strategy must be developed to define these details.
Reply (A/R/C)	*A – See 4.19 above for our general control strategy. I believe that our control strategy is in agreement with the one laid out by Dave. We can certainly have this information available to the LCP and MCSPU interface and calibrated in kg-m.*

4.28. Overpressure

Initiator	Ashby
Location (Section)	6.7
Comment	By the time you detect that there is no flow, I expect it would be too late. This is the reason for the safety valve that allows recirculation at the pump.
Reply (A/R/C)	*A – Yes we have reconsidered the use of flow meters for this purpose and propose using pressure transducers to monitor any over pressure or underpressure of the system. Safety bypass valves will be utilized to prevent damage to the system due to overpressure.*

4.29. Float valve

Initiator	Ashby
Location (Section)	6.7
Comment	Previous mechanical designs include a mechanical float valve to prevent overfilling the tanks. Has this been eliminated?
Reply (A/R/C)	*A – A float valve may be considered. We have not decided if this is the best solution though and it may prove problematic if it fails. There may be other solutions to overfilling that create fewer problems if they fail.*

4.30. Software

Initiator	Ashby
Location (Section)	6.8
Comment	I object to the term BRIO. The dynamic balance system must be integrated into the ELRIO chassis.
Reply (A/R/C)	*A – The ELRIO is an I/O interface that communicates with the TPLC via ControlNet. The first paragraph of 6.8 should read "Communication between the TPLC and the Dynamic Balance part of the ELRIO module....ControlNet protocol.*

4.31. Software interlocks

Initiator	Ashby
Location (Section)	6.8
Comment	Not all interlocks will be implemented in software
Reply (A/R/C)	*A – See discussion in comment 4.25*

4.32. MCSPU

Initiator	Ashby
Location (Section)	6.8
Comment	I think putting this information in the MCSPU is undesirable. The system should be delivered calibrated in real-world units (kg m). Why not map this in the PLC so that the LCP can be used to change the swing arm configuration and balance? The LCP can also be used to compensate for mechanical changes to the telescope in real-time. You should be able to do this without the MCSControl software running. I also think the interface to the MCSPU should be in real-world units of kg m and not fluid levels.
Reply (A/R/C)	*A –We can have the calibrated lookup table available in the PLC, so that the higher level software does not need to be running to perform the balancing. Also see discussion in comment 4.27.*

4.33. Software

Initiator	Ashby
Location (Section)	6.8
Comment	The software should maintain a balance log that is accessible though the LCP and the MCSPU interfaces. This will provide a convenient interface though which we can maintain the swing arm calibration tables. This can also be done using the Telemetry logging system but it would be good to minimize the necessary subsystem interaction.
Reply (A/R/C)	*A- See discussion on comment 4.27.*

4.34. Sensors accuracy

Initiator	Ashby
Location (Section)	7.1.6
Comment	The accuracy of the level sensors and flow meters and pump control requirements depend on the control strategy used. I would like to know more about the control strategy before commenting further on the requirements of these components.
Reply (A/R/C)	*A – See discussion in comment 4.19 for general control strategy.*

4.35. Missing information

Initiator	J. Hill
Location (Section)	General
Comment	Missing: The capacity of the rebalancing moment in each direction should be stated, and should be compared to the weight of the swing arms. (We could have a problem there if all swing arms are heavy.)
Reply (A/R/C)	*C – The capacity of the rebalancing moment in the y-axis is 820 kNm and the z-axis is 414 kNm. LBT should be responsible for determining the mass and cg location in the xy and xz plane of the swing arms and passing that to the team if it has changed from the values reported in the drawing contained in the CAN. Then we can determine whether the total moment produced by the swing arms in the deployed or retracted positions exceeds the above capacity stated and add capacity if needed.*

4.36. Control strategy

Initiator	J. Hill
Location (Section)	6.5
Comment	Text: "The system shall automatically balance the telescope based on the configuration." I think the wording needs to be clarified (the use of "automatically"). I suppose that it means that the telescope will be balanced based on a configuration table which specifies the weight distribution that is needed. And that it does not mean that the system will make an automatic fine tuning of the balance using the configuration as a starting point.
Reply (A/R/C)	*A – Yes that is correct. The system will use a lookup table for a particular configuration and pump the required amount of fluid. Fine tuning values will have to be commanded to the system externally and an additional amount of fluid will be pumped based on that request.*

4.37. Control strategy

Initiator	J. Hill
Location (Section)	6.5
Comment	Text: "Communicate with TPLC....". The requirements seem unclear about whether the balancing is done by TPLC, or by a separate system that talks to TPLC. My impression is that the entire function could be done by a remote module of TPLC; with the logic running in TPLC that tells the pumps how long to run to get to the desired depth/pressure/mass. My point is simply that some clarification is needed about how much autonomy from TPLC is required.
Reply (A/R/C)	*C – We think that all of this is carried out and commanded by the TPLC and not a separate system. Similar to how the swing arms are controlled.*

4.38. Fluid

Initiator	J. Hill
Location (Section)	7.1.2
Comment	I see no need for deionized water given that the various additives will be used. This should be equivalent to the glycol mix circulating in the telescope/instrument cooling loops.
Reply (A/R/C)	*A – This requirement for deionized water was pulled from the chiller specification (562s007h), but whatever was eventually used in that system is fine here.*

4.39. Reference

Initiator	Gusick
Location (Section)	6.4
Comment	The reference doc should be [RD1]
Reply (A/R/C)	*A*

4.40. Power supply

Initiator	Gusick
Location (Section)	6.4
Comment	There is not currently 208V allocated for the dynamic balance system – 480V and 120V UPS per RD1.
Reply (A/R/C)	*A- The motors will be connected to the Allen Bradley or similar drive so the drives will have to accept 3-phase 480 VAC.*

4.41. Interlock

Initiator	Gusick
Location (Section)	6.7
Comment	The main hardware interlock to prevent run away due to gross imbalance is the stow pins. Since the stow pins can also be pulled from the HBS local control panel, we may want some procedure on its use so the pins are not inadvertently pulled during an out of balance condition. They can also be pulled from the MCSPU engineering interface which may also need so software interlocks. It may not need to be a hardware interlock (in the PLC instead), but we probably don't want to pull the stow pins unless all of the swing arms are either fully deployed or retracted.
Reply (A/R/C)	*A - The STOW pins must not be withdrawn unless balance is verified and the swing arms are in place.*

4.42. Requirements

Initiator	Brynnel
Location (Section)	6.1
Comment	Text: “The system shall be able to resolve balance changes…” Should the text be “resolve” (measure), or “apply”, or possibly “resolve and apply” balance changes?
Reply (A/R/C)	*R- Line will be deleted. In the specification we will say the balance system can make balance changes within 3500 Nm of the commanded amount.*
Revised Reply (A/R/C)	*R – Second sentence of original reply is changed to “…the balance system will have a metering accuracy of 0.5% with a goal of 0.1%.”*

4.43. PLC

Initiator	Brynnel
Location (Section)	6.4
Comment	Text “The system shall use Allen-Bradley PLC”. Change wording to “The system shall use **existing** Allen-Bradley PLC”
Reply (A/R/C)	*A*

4.44. Communication

Initiator	Brynnel
Location (Section)	6.5
Comment	Text: "Communicate with the TPLC over fiber optic cable…" Change wording to "Communicate with the TPLC over **existing** fiber optic cable…"
Reply (A/R/C)	*A*

4.45. Interlocks

Initiator	Brynnel
Location (Section)	6.7
Comment	In addition to interlocking of pump motors, I would recommend to interlock valve operation.
Reply (A/R/C)	*A*

4.46. Pump control

Initiator	Brynnel
Location (Section)	7.1.1.
Comment	The pumps should be controlled by either a VFD or a soft start unit to avoid excessive inrush current and fluid pressure peaks.
Reply (A/R/C)	*A- See discussion in comment 4.23.*

4.47. Valve control

Initiator	Brynnel
Location (Section)	7.1.3.1
Comment	I guess some valves are operated by 120VAC single-phase, not three-phase 208VAC?
Reply (A/R/C)	*R – The valves are 480 VAC 3 –phase.*

4.48. Sensor supply

Initiator	Brynnel
Location (Section)	7.1.6.1
Comment	I do not think that fluid level sensors would require 208VAC?
Reply (A/R/C)	*A – You are correct they are 24 VDC.*

--oOo--

Doc_info_start
Title: *LBT Dynamic Balancing System - Requirements Review Items*
Document Type: Report
Source: Steward Observatory
Issued by: Joar Brynnel
Date_of_Issue: *20-Jan-07*
Revised by:
Date_of_Revision:
Checked by:
Date_of_Check:
Accepted by:
Date_of_Acceptance:
Released by:
Date_of_Release:
File Type: MS Word
Local Name: *LBT Dynamic Balancing System - Requirements Review Items*
Category: *500*
Sub-Category: *580*
Assembly: *Fill in Assembly name here*
Sub-Assembly:
Part Name:
CAN Designation: *580s006*
Revision: *a*
Doc_info_end