WS / Origin	Description	LOW / MID / COMMON	Science Implication	Science Impact
5.39	**INFRA_SA Renewable energy to outer dishes** The 9 outer dishes on MID (3 on each spiral arm) could be powered by solar in-situ rather than from a central power supply, removing the need for overhead power lines. Reduction of both construction and operations costs but no impact on science.	**MID**	**None**	1
5.34	**Maximise use of code produced during Pre-Construction** Pre-existing code is being identified for re-use in SKA. This may include code developed in precursors, code developed as part of other projects (typically open source) and code developed in pre-construction as part of prototyping.	**COMMON**	**None**	1
5.38	**Simplify DDBH LOW** The Digital Data Back Haul (DDBH) is the science data network connecting the antenna stations to CSP. This option explores the possibility to simplify the DBBH for LOW, going from a managed network design (exploiting network switches to forward data) to a point-to-point connection (where data communication is established by other means).	**LOW**	**None**	1
5.38	**Simplify DDBH MID** The Digital Data Back Haul (DDBH) is the science data network connecting the antennas to CSP. This option explores the possibility to simplify the DBBH for MID, going from a managed network design (exploiting network switches to forward data) to a point-to-point connection (where data communication is established by other means).	**MID**	**None**	1
5.25.2	**Reduce PSS-MID: A, 750 nodes to 500 nodes** This cost control option involves necessitating that the CSP.PSS design processes 3 tied array search beams per PSS processing node on MID. Currently the design processes 2 tied array search beams per PSS processing node on MID. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing a complete pulsar search so not achieving the same science). It is considered that the change from 2 beams/node to 3 beams/node will potentially be possible without needing to perform an incomplete search. If it is not possible this equates to a cut in the number of pulsar beams that can be processed across the full search parameter space by 500, i.e. from 1500 to 1000 beams.	**MID**	**Likely none, or small reduction of pulsar search parameter space.**	1
5.25.2	**Reduce PSS-LOW: A, 250 nodes to 167 nodes** This cost control option involves necessitating that the CSP.PSS design processes 3 tied array search beams per PSS processing node on LOW. Currently the design processes 2 tied array search beams per PSS processing node on LOW. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing a complete pulsar search so not achieving the same science). It is considered that the change from 2 beams/node to 3 beams/node will potentially be possible without needing to perform an incomplete search. If it is not possible this equates to a cut in the number of pulsar beams that can be processed across the full search parameter space by 166, i.e. from 500 to 334 beams.	**LOW**	**Likely none, or small reduction of pulsar search parameter space.**	1
5.35	**Reduce CBF-MID: Freq. Slice variant of CSP design vs. MeerKAT-based design** This cost control option involves adopting either the Frequency Slice CBF (Correlator – Beam-former) design from CSP, or a MeerKAT-based CBF design. The chosen option would need to satisfy the current System requirements for processed bandwidth, zoom modes, numbers of pulsar search and timing beams etc.	**MID**	**None**	1

5.19	**MID Frequency and Timing Standard: SaDT solution vs. MeerKAT-based solution** This cost control option involves adopting either the SaDT design, or a MeerKAT-based design. The chosen option would need to satisfy the current System requirements for frequency stability and timing precision.	MID	None	1
5.36	**MID SPF Digitisers: DSH solution vs. MeerKAT-based solution** This cost control option involves adopting either the DSH design, or a MeerKAT-based design. The chosen option would need to satisfy the current System requirements.	MID	None	1
5.26 / 5.29	**LOW RPF: Early Digital Beam Formation vs. Analogue Beam Formation** This cost control option involves a change to the beam forming architecture by placing either a digital or analogue beam-former immediately adjacent to the stations, thereby eliminating long distance analogue signal transport. The chosen option would need to satisfy the current System requirements.	LOW	None	1
2	**LOW Antenna: Log Periodic Design vs. Dipole Design** This option refers to undertaking a choice of antenna that best matches the scientific needs and cost constraints. Since none of the current antenna designs meet the System Requirements, further work is needed to optimise the antenna solution.	LOW	None of the current designs meet the L1 requirements	3
8	**SDP- HPC: Deploy 200 Pflops (rather than 260 Pflops)** It is expected that the cost of SDP processors will decrease in time due to more efficient and cheaper technology becoming available (Moore's Law gain). Therefore, re-sizing the first major purchase and assembling the full 260 Pflops SDP system in stages, rather than in a single deployment, results in a saving. If a smaller SDP is initially deployed, computationally demanding observations need to be observed for smaller fractions of time, in order for the sustained load on SDP to be compatible with the reduced system size. Those observations will still be possible, but will be accumulated more slowly.	COMMON	Lower allowed duty cycle for HPC-intensive observations.	2
5.24.3	**Reduce Bmax MID from 150 to 120 km: Case A, remove 3 dishes, but keep infra to 150km** There are three variants (this one and the next two) on the SKA Members statement regarding the r baselining decision of 6 March 2015, which stated "a target of delivering baseline lengths of 150km, but with a fall-back of 120km if funding is constrained". This reduction impacts the 3 outer dishes or the spiral arms, resulting in a ~20% loss of angular resolution for the HPSO objective on proto-planetary disks. In the cases that the 3 dishes are removed completely (A and C), a small loss in overall sensitivity occurs. In case A, the dishes can be easily restored if funds become available, a the Infrastructure (pads, fibre, roads) are in place. In case B the dishes are relocated to the core, improving sensitivity for other HPSOs, e.g., Pulsars, HI. In cases where the dishes are completely removed it will be very difficult to add them back at a later date.	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	2
5.24.2	**Reduce Bmax MID from 150 to 120 km: Case B, remove infra, but add dishes to core** See comments above.	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	2
5.24.1	**Reduce Bmax MID from 150 to 120 km: Case C, remove infra, remove dishes** See comments above.	MID	Reduction of maximum achievable resolution by 20%, although can be partially recovered with data weighting and longer integration times.	2
5.13.2	**Reduce Bandwidth output of band 5 to 2.5GHz** This cost control option involves reducing the instantaneous bandwidth of Band 5 from 2 x 2.5 GHz to 1 x 2.5 GHz. Simultaneous line measurements of lines separated by more than 2.5 GHz would then not be possible. However, if the CSP-MID Frequency Slice design (see above) is adopted one could place multiple 200-MHz Frequency Slices anywhere within Band 5, to have a cumulative but not necessarily contiguous bandwidth of 2.5 GHz across Band 5. Pulsar timing could not have 2x2.5 GHz bandwidth for the 8 pulsar timing beams but could trade beams for	MID	Longer Band 5 observing times for some applications (2x)	2

	bandwidth so as to have (for example) 4 pulsar timing beams each with 2x2.5 GHz bandwidth. Planned targeted pulsar searches in Band 5 would have reduced sensitivity of x sqrt(2), i.e. would require increased observing time of a factor of 2 for the same sensitivity.			
5.5.2	**Reduce MID Band 5 feeds: A, from 130 to 67** In order to preserve the HPSO on protoplanetary disks, it is proposed that the 67 remaining Band 5 feeds would be deployed primarily on the spiral arm dishes. This would impact observations that require good brightness sensitivity (including Galactic centre pulsar searches) and VLBI observations (not HPSOs). The full Band 5 deployment would be possible once more funds are available.	**MID**	**High resolution Band 5 HPSOs preserved. Low resolution and tied array Band 5 objectives severely impacted.**	2
5.25.2	**Reduce PSS-LOW: B, 167 nodes to 125 nodes** This cost control option involves necessitating that the CSP.PSS design processes 4 tied array search beams per PSS processing node on LOW. Currently the design processes 2 tied array search beams per PSS processing node on LOW. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing as complete a pulsar search). It is considered that the change from 2 beams/node to 3 beams/node will likely be possible without needing to perform an incomplete search. It is not clear if 4 beams/node will be possible. If it is not possible, then this equates to a cut in either the number of pulsar beams or the volume of pulsar search parameter space by a factor of 167/125 = 1.3.	**LOW**	**Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space**	2
5.25.2	**Reduce PSS-MID: B, 500 nodes to 375 nodes** This cost control option involves necessitating that the CSP.PSS design processes 4 tied array search beams per PSS processing node on MID. Currently the design processes 2 tied array search beams per PSS processing node on MID. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing as complete a pulsar search). It is considered that the change from 2 beams/node to 3 beams/node will likely be possible without needing to perform an incomplete search. It is not clear if 4 beams/node will be possible. If it is not possible, then this equates to a cut in either the number of pulsar beams or the volume of pulsar search parameter space by a factor of 500/375 = 1.3.	**MID**	**Likely reduction in processed PSS beam number (1.3x) or pulsar search parameter space**	2
5.35	**Reduce MID CBF and DSH BW: 5 to 1.4 GHz** This cost control option involves reducing the MID CBF and DSH digitisation bandwidth to 1.4 GHz, i.e. so that 1.4 GHz, rather than 2 x 2.5 GHz, of Band 5 could be used. Simultaneous line measurements of lines separated by more than 1.4 GHz would then not be possible. Continuum imaging applications and targeted pulsar searches in Band 5 would have reduced sensitivity of x sqrt(~3.6), i.e. would require increased observing time of a factor of ~3.6 for the same sensitivity. Observations in SPF Bands 1 and 2 are unaffected.	**MID**	**Longer observing times to achieve continuum sensitivity in Band 5 (3.6x)**	2
5.31	**Reduce CBF-LOW BW: A, 300 to 200 MHz** This option entails reducing the maximum bandwidth processed by the correlator from 300 to 200 MHz. Continuum applications may require longer integration times to achieve the same sensitivity. Multi-beamed imaging observations, that relied on 2x150 MHz beams, would instead be limited to 2x100MHz beams.	**LOW**	**Longer observing times for continuum applications (1.5x)**	2
8	**SDP- HPC: Deploy 150 Pflops (from 200 Pflops)** It is expected that the cost of SDP processors will decrease in time due to more efficient and cheaper technology becoming available (Moore's Law gain). Therefore, re-sizing the first major purchase and assembling the full 260 Pflops SDP system in stages, rather than in a single deployment, results in a saving. If a smaller SDP is initially deployed, computationally demanding observations need to be observed for smaller fractions of time, in order for the sustained load on SDP to be compatible with the reduced system size. Those observations will still be possible, but will be accumulated more slowly.	**COMMON**	**Lower allowed duty cycle for HPC-intensive observations.**	3

5.30.0	**Reduce Bmax LOW to 50km: A, remove infra, add 18 stations to core** In this scenario, the outer three clusters of (6x3) stations are moved into the central region of 3km diameter. The reduction in maximum baseline may have adverse consequences for foreground continuum source characterisation and removal.	LOW	**Science Risk to EoR: Bmax.**	3
5.30.0	**Reduce Bmax LOW to 50km: B, remove 18 stations** Similar to the previous scenario where the outer three clusters of (6x3) stations are removed, but these are not added to the central core region. The reduction in maximum baseline may have adverse consequences for foreground continuum source characterisation and removal.	LOW	**Science Risk to EoR: Bmax**	3
5.25.2 / Deeper Savings	**Reduce PSS-LOW: C, 125 nodes to 83 nodes** This cost control option involves necessitating that the CSP.PSS design processes up to 6 tied array search beams per PSS processing node on LOW. Currently the design processes 2 tied array search beams per PSS processing node on LOW. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing as complete a pulsar search). It is considered that the change from 2 beams/node to 3 beams/node will likely be possible without needing to perform an incomplete search. It is unlikely that 6 beams/node will be possible. If it is not possible, then this equates to a cut in either the number of pulsar beams or the volume of pulsar search parameter space by a factor of 167/83 = 2.	LOW	**Likely reduction in processed PSS beam number (2x) or pulsar search parameter space**	3
5.25.2 / Deeper Savings	**Reduce PSS-MID: B, 375 nodes to 250 nodes** This cost control option involves necessitating that the CSP.PSS design processes up to 6 tied array search beams per PSS processing node on MID. Currently the design processes 2 tied array search beams per PSS processing node on MID. To achieve this would require improved processing algorithms (which may not be possible) or the reduction in search parameter space (i.e. not performing as complete a pulsar search). It is considered that the change from 2 beams/node to 3 beams/node will likely be possible without needing to perform an incomplete search. It is unlikely that 6 beams/node will be possible. If it is not possible, then this equates to a cut in either the number of pulsar beams or the volume of pulsar search parameter space by a factor of 500/250 = 2.	MID	**Likely reduction in processed PSS beam number (2x) or pulsar search parameter space**	3
5.30a	**Reduce Bmax LOW to 40km: C, remove next 18 stations** This scenario involves removing the second outermost clusters of (3x6) stations as well as the supporting infrastructure. These are not added to the core region. The reduction in maximum baseline may have adverse consequences for foreground continuum source characterisation and removal.	LOW	**Science Risk to EoR: Bmax**	3
8	**SDP- HPC: Deploy 100 Pflops (from 150 Pflops)** It is expected that the cost of SDP processors will decrease in time due to more efficient and cheaper technology becoming available (Moore's Law gain). Therefore, re-sizing the first major purchase and assembling the full 260 Pflops SDP system in stages, rather than in a single deployment, results in a saving. If a smaller SDP is initially deployed, computationally demanding observations need to be observed for smaller fractions of time, in order for the sustained load on SDP to be compatible with the reduced system size. Those observations will still be possible, but will be accumulated more slowly.	COMMON	**Lower allowed duty cycle for HPC-intensive observations.**	4
8	**SDP- HPC: Deploy 50 Pflops (from 100 Pflops)** It is expected that the cost of SDP processors will decrease in time due to more efficient and cheaper technology becoming available (Moore's Law gain). Therefore, re-sizing the first major purchase and assembling the full 260 Pflops SDP system in stages, rather than in a single deployment, results in a saving. If a smaller SDP is initially deployed, computationally demanding observations need to be observed for smaller fractions of time, in order for the sustained load on SDP to be compatible with the reduced system size. Those observations will still be possible, but will be accumulated more slowly.	COMMON	**Lower allowed duty cycle for HPC-intensive observations.**	4

5.24 / Deeper Savings	**Remove 11 MID Dishes from core** This cost control option involves removing 11 SKA1 dishes from within the inner 1.2 km radius. In the current design there are 70 SKA1 (15-m) and 49 MeerKAT (13.5-m) dishes within this radius. In the case of high surface brightness imaging and pulsar searches this reduces the core collecting area by 10%. Pulsar acceleration searches require instantaneous sensitivity (or extra computing proportional to (Tobs_new/Tobs_now)^3) so they are disproportionately impacted, i.e. can not be recouped with extra Tobs. Non-binary (i.e. non-HPSO-related) pulsars and low resolution imaging are affected such that ~20% extra observing time would recoup the loss.	MID	10% Sensitivity loss in core	4
5.30 / Deeper Savings	**Remove 54 LOW stations from core** In this measure, 54 stations are randomly removed from the inner 1.5 km radius region (where there are currently 282 stations). There is a 20% loss in core sensitivity, which would require about 40% increased integration time to compensate.	LOW	20% Sensitivity loss in core	4
5.24 / Deeper Savings	**Remove additional 11 MID Dishes from core** This cost control option involves removing 22 SKA1 dishes from within the inner 1.2 km radius. In the current design there are 70 SKA1 (15-m) and 49 MeerKAT (13.5-m) dishes within this radius. In the case of high surface brightness imaging and pulsar searches this reduces the core collecting area by 20%. Pulsar acceleration searches require instantaneous sensitivity (or extra computing proportional to (Tobs_new/Tobs_now)^3) so they are disproportionately impacted, i.e. can not be recouped with extra Tobs. Non-binary (i.e. non-HPSO-related) pulsars and low resolution imaging are affected such that ~40% extra observing time would recoup the loss.	MID	20% Sensitivity loss in core	4
5.30 / Deeper Savings	**Remove additional 54 LOW stations from core** In this measure, an additional 54 stations are randomly removed from the inner 1.5 km radius region (where there are currently 282 stations) for a total loss of 108 stations in the core, and 36 stations beyond 40km. There is a 40% loss in core sensitivity, which would require a doubling of integration time to compensate.	LOW	40% Sensitivity loss in core	4
5.24.2	**Reduce Bmax MID from 120 to 100 km: D, remove infra, remove next 3 dishes** The total number of SKA1 dishes removed is now 6, resulting in 127/133 SKA1 dishes. Sensitivity loss is small (about 3%), but the maximum angular resolution is decreased by 33%.	MID	Lose Science (Planetary disks, High resolution Star Formation)	4
5.5.1	**Remove MID Band 1 feeds: 105 to 0** This measure considers delaying the deployment of band1 feeds on MID antennas. These could be deployed once further funding were available. Science objectives exploiting Band 1 will not be possible until this functionality is reinstated.	MID	Lose Science (Cosmology, Galaxy Evolution)	4
5.5.2	**Reduce MID Band 5 feeds: B, from 67 to 0** Band 5 is not initially deployed, but can be deployed once funds become available.	MID	Lose Science (Planetary disks, Star Formation)	4