

SKA1 - Infrastructure Element Australia

SKA Engineering meeting
3rd October 2016

Antony Schinckel (Consortium Lead)
Shandip Abeywickrema (Project Engineer)
Rebecca Wheadon (Project Manager)





- Introduction
- Who is INAU
- Status
- Milestone progress
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary



- **Introduction**
- Who is INAU
- Status
- Milestone progress
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary



- Health, Safety and Environment
 - Underlying principles in all aspects of design :
 - You won't get safe designs as a by-product of the normal design process
 - Focus is wrong !
 - You need the design process to naturally include HSE
 - HSE identification in process of designing
 - Don't forget HSE of staff in design process !
 - Will prompt them in their design work
 - Aurecon's "Take 5"

TAKE 5

STOP

THINK

IDENTIFY

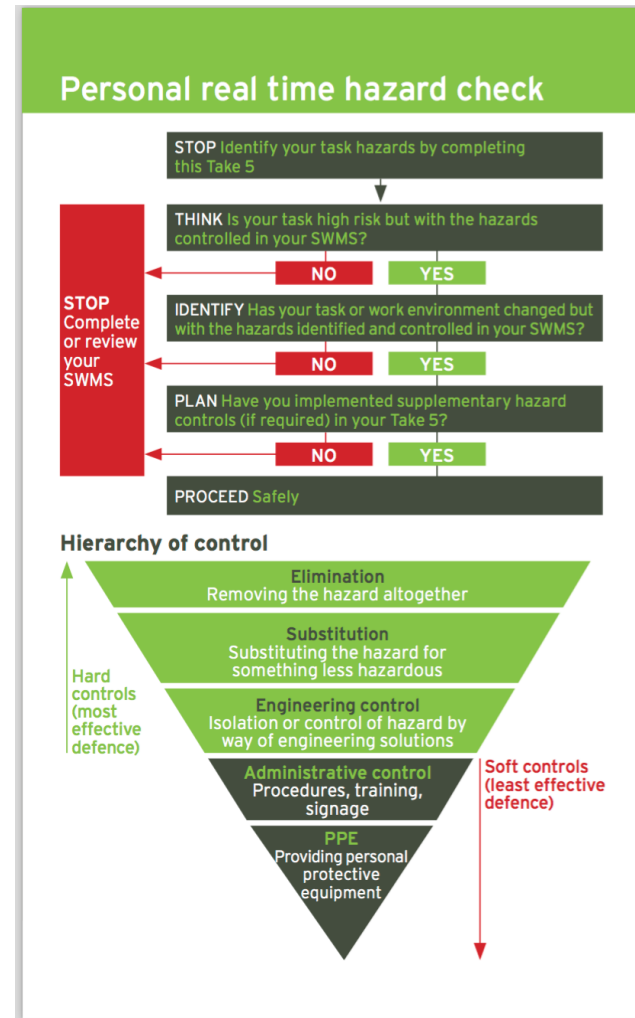
PLAN

PROCEED

Health, safety and environment



aurecon



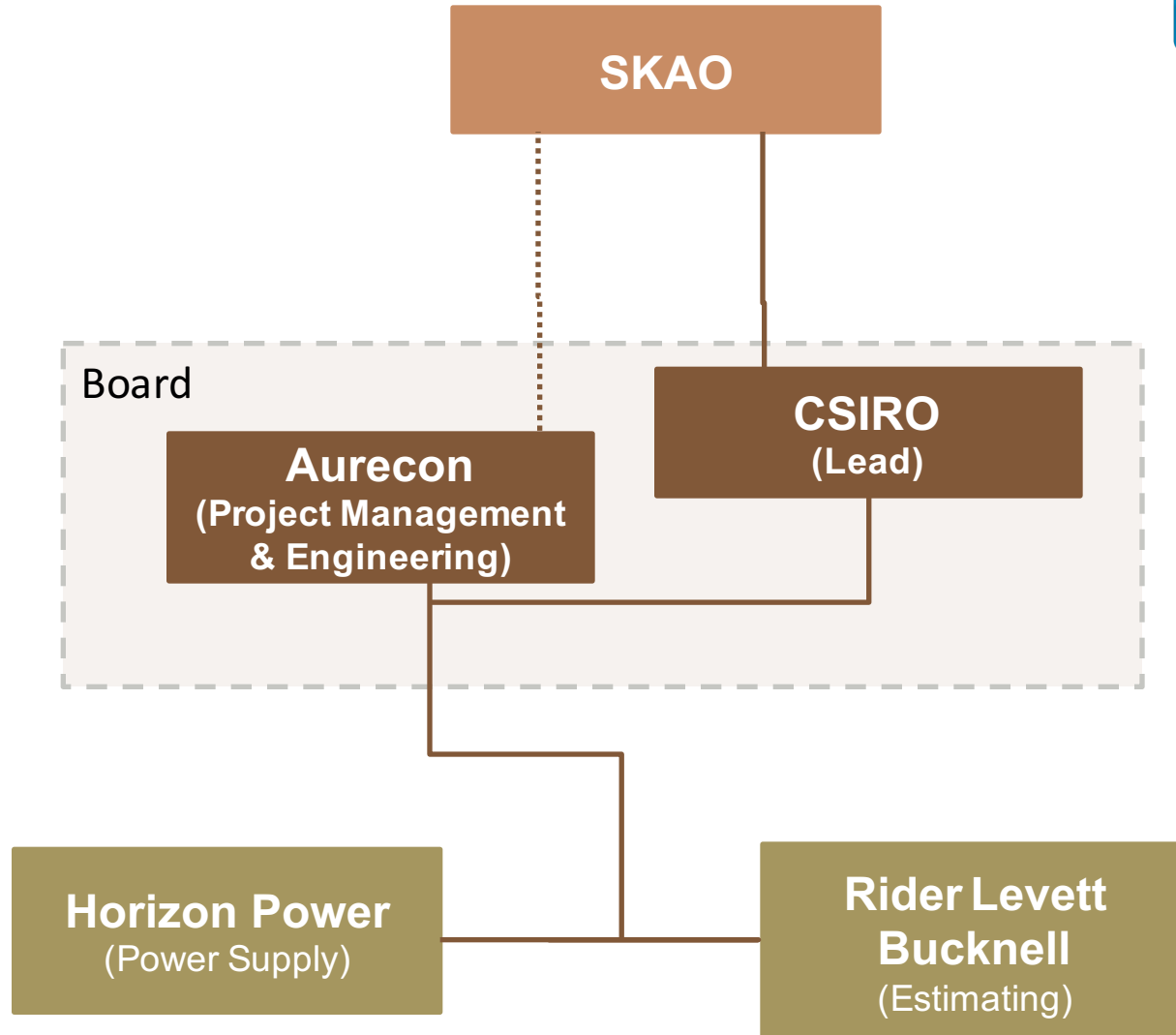


- 2016 :
 - Slow
 - Requirements evolution
 - Level 1 Rev up to 8, 9 and 10 to come
 - ICD development
 - Studies
 - Powerline tradeoff,
 - Use of small solar power stations for remote Low stations
 - “Honing” of cost estimates



- Introduction
- **Who is INAU**
- Status
- Milestone progress
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary

Consortium members





Aurecon

Name	Role
Stephen Negus	INFRA AUS Board Chairman
Rebecca Wheadon	Project Manager
Shandip Abeywickrema	Project Engineer & Lead Subsystem Engineer - Buildings
James Massoud	Lead Subsystem Engineer - Power
Justin Adamson	Lead Subsystem Engineer - Water & Sanitation, Access
Kjeld Madsen	System Engineer
Angus Leitch	Verification Team Leader
Karen Gardon	Risk Manager
Jo Duncan	Project Controls
Lisa Simmonds	Health & Safety Manager

CSIRO

Name	Role
Antony Schinckel	Consortium Lead
Graham Allen	Subsystem Engineer – Power & Vehicles
Carol Wilson	Subsystem Engineer – RFI Lead
Kate Chow	Science Officer
Ron Beresford	Subsystem Engineer
Raji Chekkala	Configuration Manager
Kerry Ardern	General engineer, HSE

RLB

Name	Role
Mark Bendotti	Cost Estimating Lead
Alistair Aitken	Cost Estimating
Asitha Perera	Cost Estimating

Horizon Power (TBC)

Name	Role
David Edwards	Subsystem Engineer - Power
David Stephens	Subsystem Engineer - Power
Laurie Curro	Verification

Board: Lewis Ball (CASS)
Steve Negus (CASS)
SKAO, DIIS Observers

*Not all team members shown



- Introduction
- Who is INAU
- **Status**
- Milestone progress
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary

Current Status



Complete:

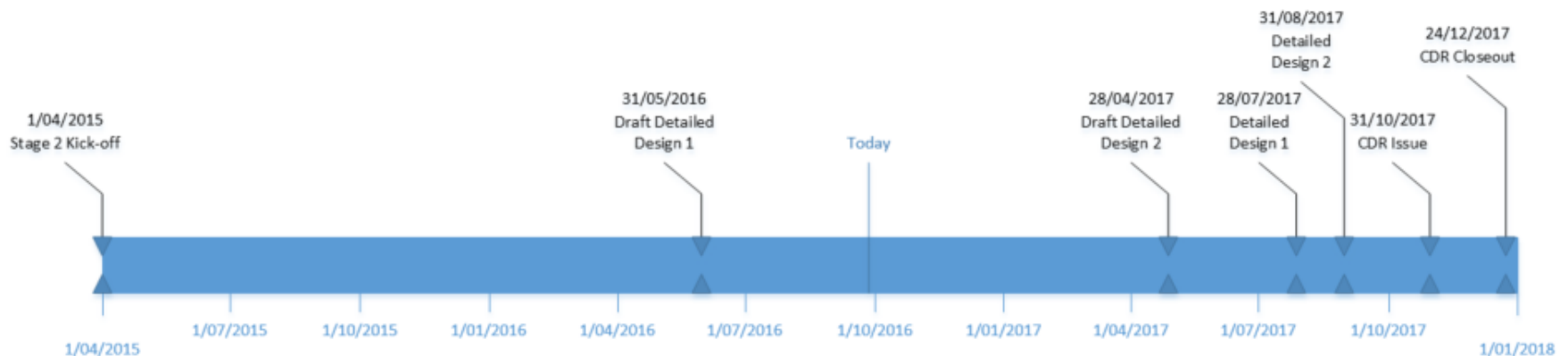
- Topographical survey
- Preliminary flora and fauna surveys (Aecom)
- Building options for SKA1 Low CPF
- Overhead powerline study
- Remote station Solar PV study
- Draft design reports for Access, Site Monitoring, Communications and Vehicles
- System Engineering L2 and 3 requirements

Underway:

- ECPs, ICD completion
- Many detailed aspects of design work, including RAMs etc

Impacted due to delay in Low configuration:

- Detailed configuration of power, access tracks – example work done



INAU Milestone Timeline



- Introduction
- Who is INAU
- Status
- **Milestone progress**
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary

Milestone Progress



Milestone date	Stage 2 Milestones	Completed
Apr-15	Kick Off	Yes
Jul-15	Plan Milestone, SEMP and Survey tender docs approved	Yes
Oct-15	Health & Safety Management Plan, Cost plan update post RBS	Yes
Nov-15	Ground survey/feature survey complete	Yes
Jan-16	Preliminary design and study of alternative overhead power option	Yes
May-16	Draft Detailed Design Milestone 1	Yes
Apr-17	Draft Detailed Design Milestone 2, Draft EMC Control Plans	-
May-17	Draft RAM Analysis, Preliminary power distribution and access networks complete	-
Jul-17	Detailed Design Milestone 1, Geotechnical and water survey complete	-
Aug-17	Detailed Design Milestone 2, Plan Milestone (Construction Management, Operations and Maintenance)	-
Sep-17	EMC Control Plans, Detailed Cost Report, Final Risk Report	-
Oct-17	Detailed Design Specification for CDR, CDR Issue	-
Dec-17	CDR Closeout	-



- Introduction
- Who is INAU
- Status
- Milestone progress
- **Key areas of design:**
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- Summary

SKA1-LOW Location



- SKA1-LOW located within Boolardy Station, Murchison, WA (3,500 sq km)
- LOW core location selected, approx. 19.5km between LOW core and ASKAP core
- Working to released configuration 0422 (May 016 release)



SKA1-Low Configuration

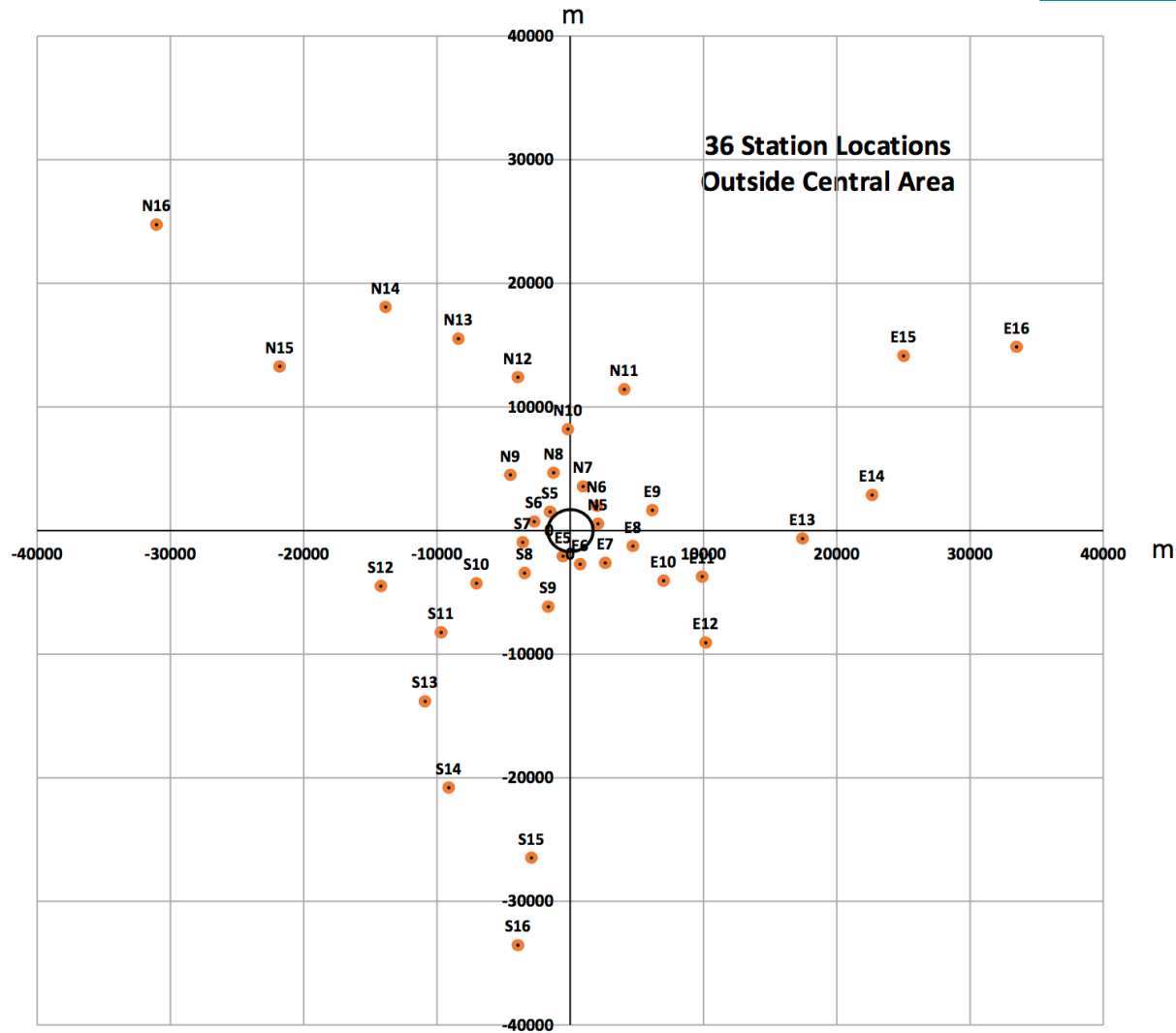
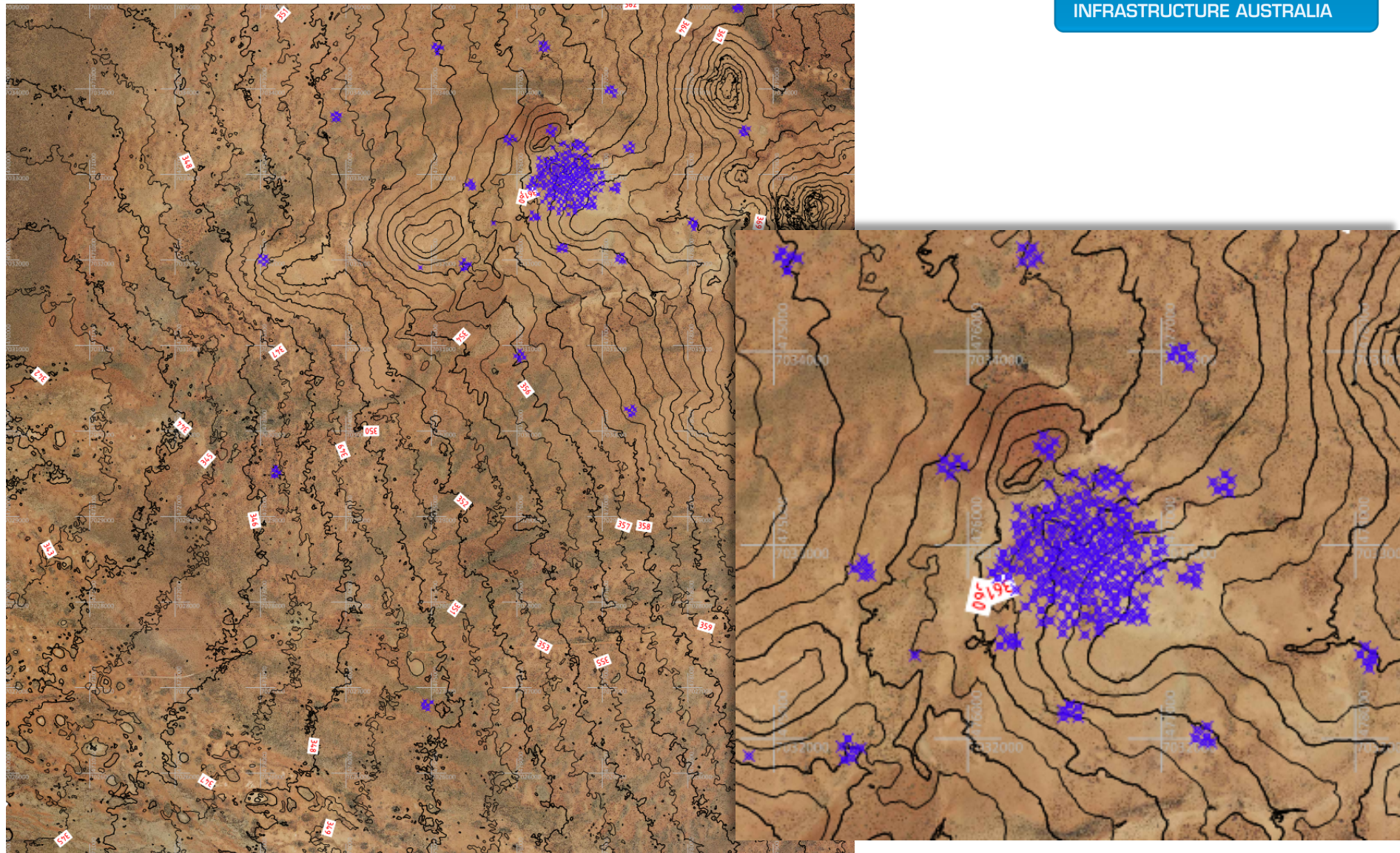
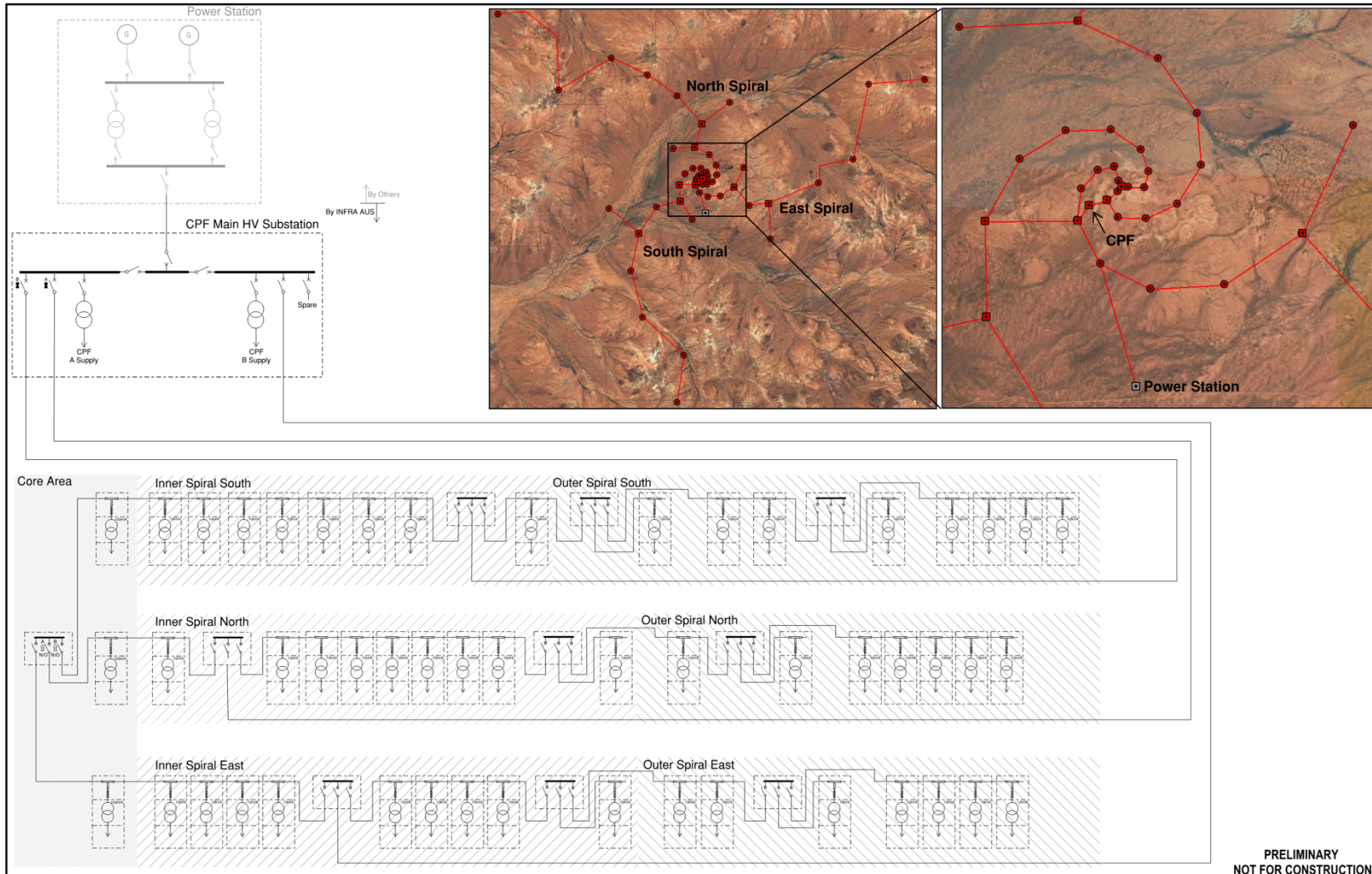


Figure 1: The configuration of the 36 cluster locations outside the central area, 12 on each spiral arm.

Prepared Ground - Low Core – contours

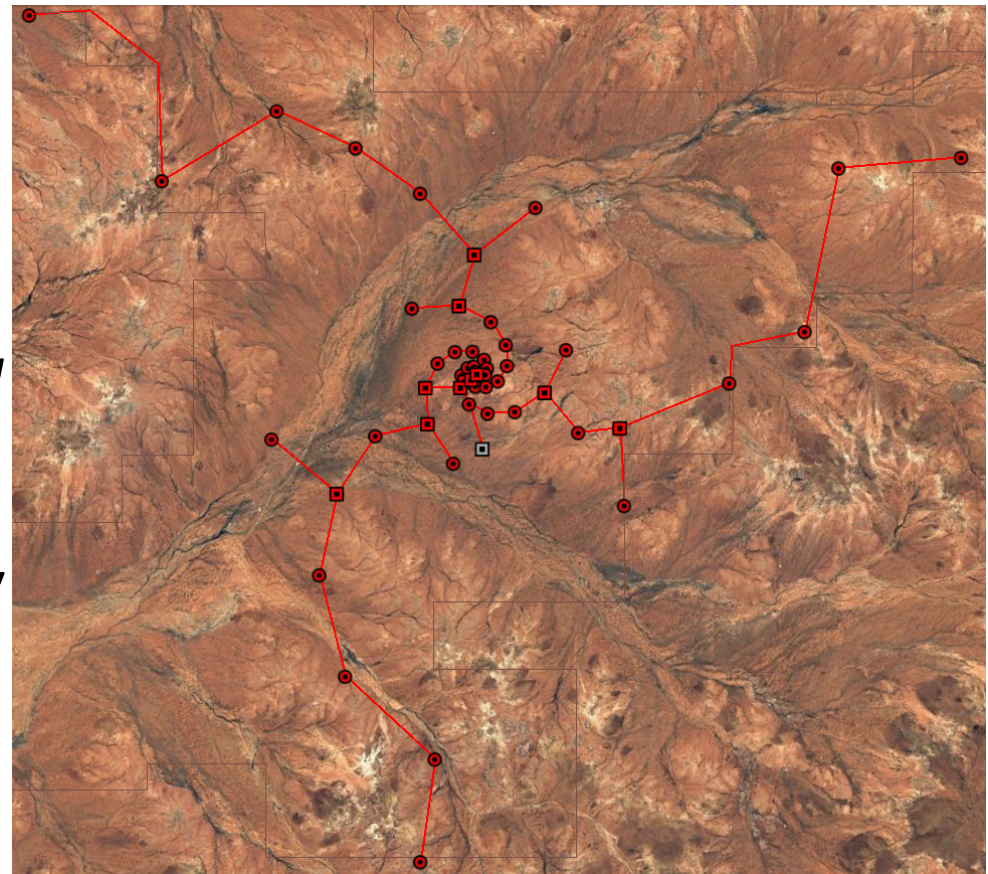


Power Distribution - HV



PRELIMINARY
NOT FOR CONSTRUCTION

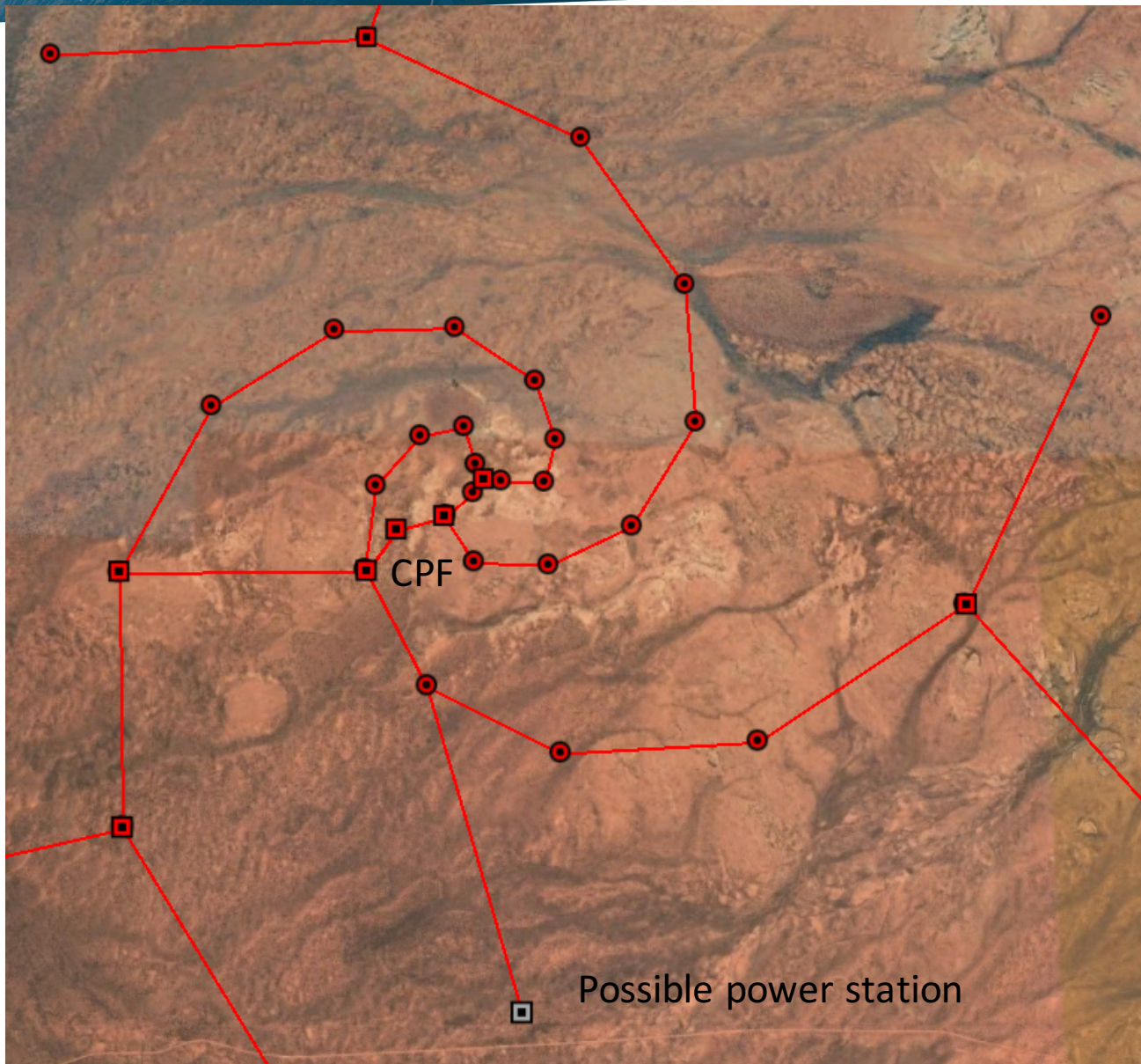
- *Buried cable from on-site Power Station to Low CPF*
- *Distributed power to spirals in the dense core (500m) and out to 6.4km radius (regular 'spirals')*
- *Outer stations on long spiral arms may be a mix of buried cable and solar PV*
- *Stations close to ASKAP may be fed from ASKAP Power*
- *Trade-off study to be updated during 2017*



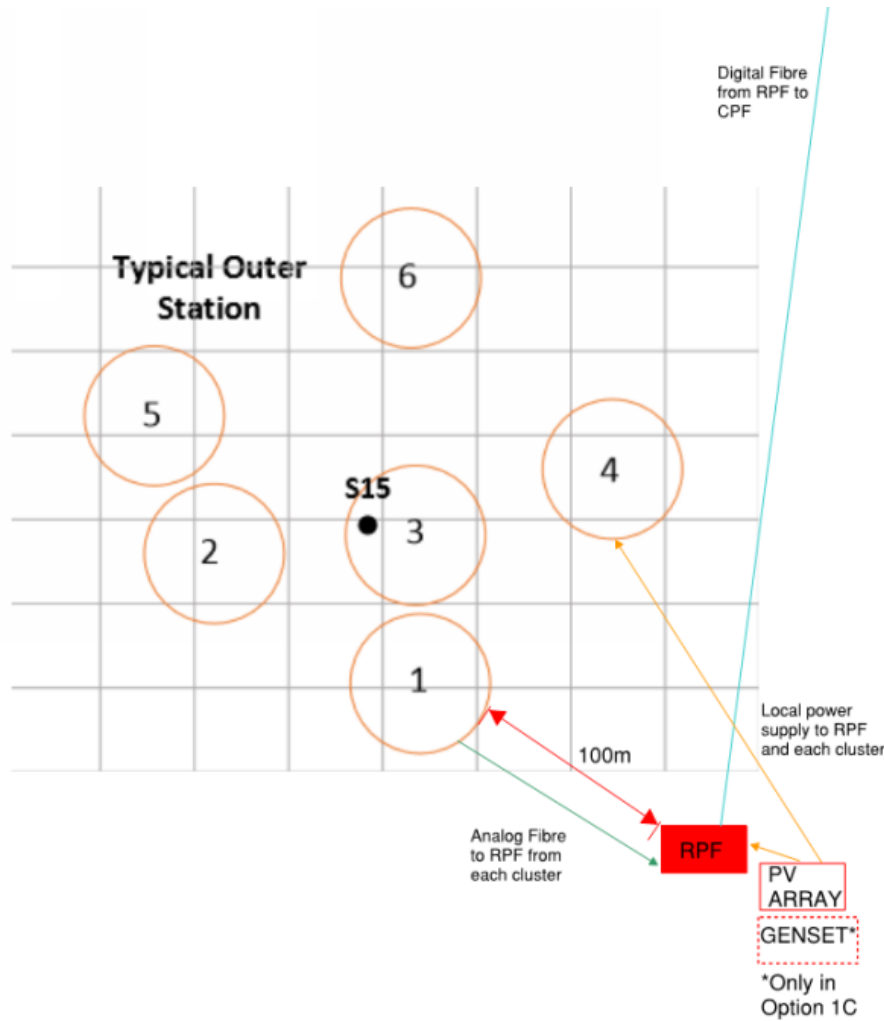
Power Distribution - HV



INFRASTRUCTURE AUSTRALIA



Power Distribution – Remote Stations Solar



Power Distribution – Remote Stations Solar



Table 7: Option 1C (99.5% Availability with Genset) Breakpoint Analysis

SKA Solar PV Study		Option 1C 99.5% Availability with Genset									
Distance point to point (+15%)		N15-N16	E15-E16	E14-E16	N14-N15	S15-16	S14-S15	E13-E14	E11-E13	S13-S14	N13-14
		16940	9798	13214	10684	8200	9683	7257	9350	8441	6935
	Capital Costs	(563,762)	(7,593)	(273,607)	(76,588)	116,849	1,363	190,283	27,295	98,081	215,359
	Net Present Value over 25 years (4%)	(405,696)	150,473	(115,541)	81,478	274,915	159,428	348,349	185,361	256,147	373,424
	CUMULATIVE CAPITAL COST	(563,762)	(571,355)	(844,962)	(921,551)	(804,702)	(803,339)	(613,056)	(585,761)	(487,680)	(272,322)
	CUMULATIVE NPV	(405,696)	(255,223)	(370,764)	(289,287)	(14,372)	145,056	493,405	678,766	934,913	1,308,337
-10%	Battery Cost - reduction in capital Cost by 10%										
	Capital	(580,885)	(24,715)	(290,730)	(93,711)	99,726	(15,760)	173,161	10,172	80,959	198,236
	NPV	(432,510)	123,660	(142,355)	54,664	248,101	132,615	321,535	158,547	229,333	346,611
	CUMULATIVE CAPITAL COST	(580,885)	(605,600)	(896,330)	(990,041)	(890,315)	(906,074)	(732,914)	(722,741)	(641,783)	(443,547)
	CUMULATIVE NPV	(432,510)	(308,850)	(451,205)	(396,541)	(148,440)	(15,825)	305,710	464,257	693,590	1,040,201
-20%	Battery Cost - reduction in capital Cost by 20%										
	Capital	(598,007)	(41,838)	(307,852)	(110,833)	82,604	(32,882)	156,038	(6,950)	63,836	181,114
	NPV	(459,323)	96,846	(169,168)	27,851	221,288	(105,802)	294,722	131,734	202,520	319,797
	CUMULATIVE CAPITAL COST	(598,007)	(639,845)	(947,697)	(1,058,531)	(975,927)	(1,008,809)	(852,771)	(859,721)	(795,885)	(614,772)
	CUMULATIVE NPV	(459,323)	(362,477)	(531,645)	(503,795)	(282,507)	(388,309)	(93,587)	38,147	240,667	560,464
-50%	Battery Cost - reduction in capital Cost by 50%										
	Capital	(648,690)	(93,205)	(359,220)	(162,201)	31,236	(84,250)	104,671	(58,318)	12,469	129,746
	NPV	(539,764)	16,406	(249,608)	(52,589)	140,848	25,361	214,282	51,294	122,080	239,357
	CUMULATIVE CAPITAL COST	(648,690)	(741,895)	(1,101,115)	(1,263,316)	(1,232,080)	(1,316,329)	(1,211,659)	(1,269,977)	(1,257,508)	(1,127,762)
	CUMULATIVE NPV	(539,764)	(523,357)	(772,966)	(825,555)	(684,708)	(659,346)	(445,064)	(393,771)	(271,691)	(32,334)



Buildings that require major RFI shielding:

- Central Processor Facility (CPF) ~ 1100 + sq metres
- Remote Processor Facility (RPF) ~ 36 x 20 sq m

Other facilities required:

- Storage of spares (appropriate location: MRO, Geraldton, further back ?)
- Maintenance facilities (location location location
- Accommodation:
 - Temporary construction camp (~250 people, 4 years)
 - Permanent accommodation facility (~50 people, 50 years)
 - Travel distance optimisation :
 - RFI impacts ? Shielding / restrictions may apply
- Engineering Operations Centre (**EOC**) and Integration and Test Facility (**ITF**)
 - Clear requirement for both for SKA
 - Possible initial use of EOC as ITF (schedule dependent)
 - A path for the provision of these buildings has been started in Australia

Buildings – CPF Rack Budgets



- Central building (CPF) only
- Current estimates (Oct 2016)

- New facility close to Low core
- Building area ~1100+ sq m required.
- Modular building concept, similar to successful strategy for ASKAP
- Using CSIRO RFI/EMC standards for initial design
 - Double shielded for primary DSP systems
- Minimal additional rooms
 - Operations / Maintenance models require certain key facilities.
 - Refine requirements Q3 2016 with SKAO
- RPFs (aka “huts”) required on the spiral arms for housing station ADC, SaDT etc
 - Tradeoff study on use local solar power supply

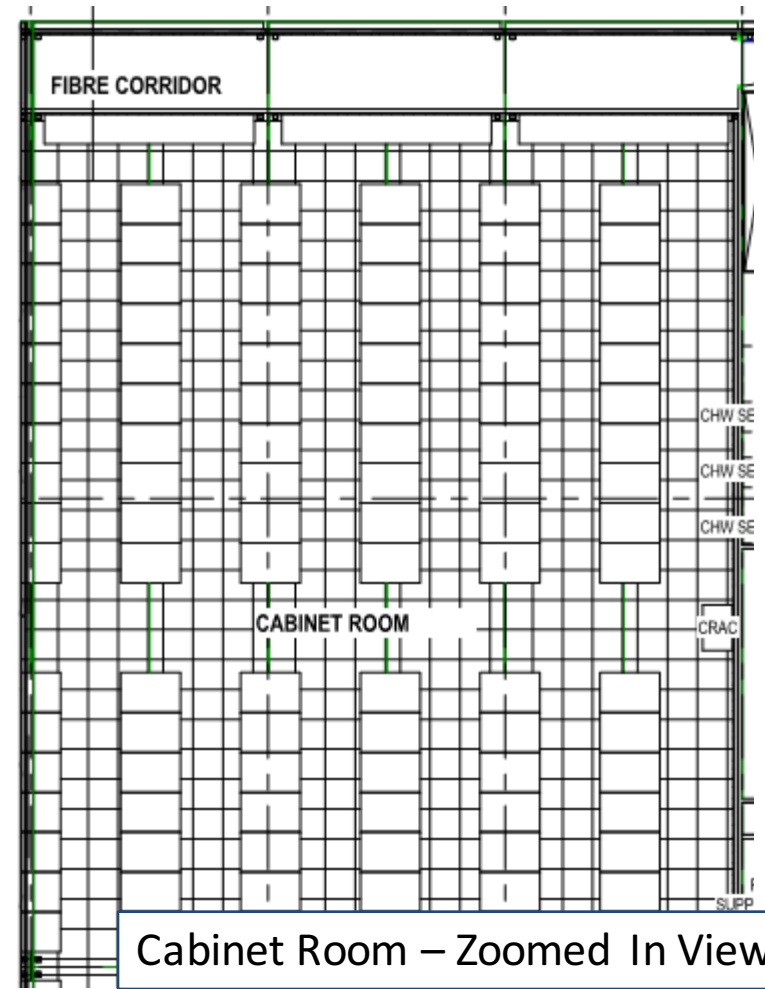
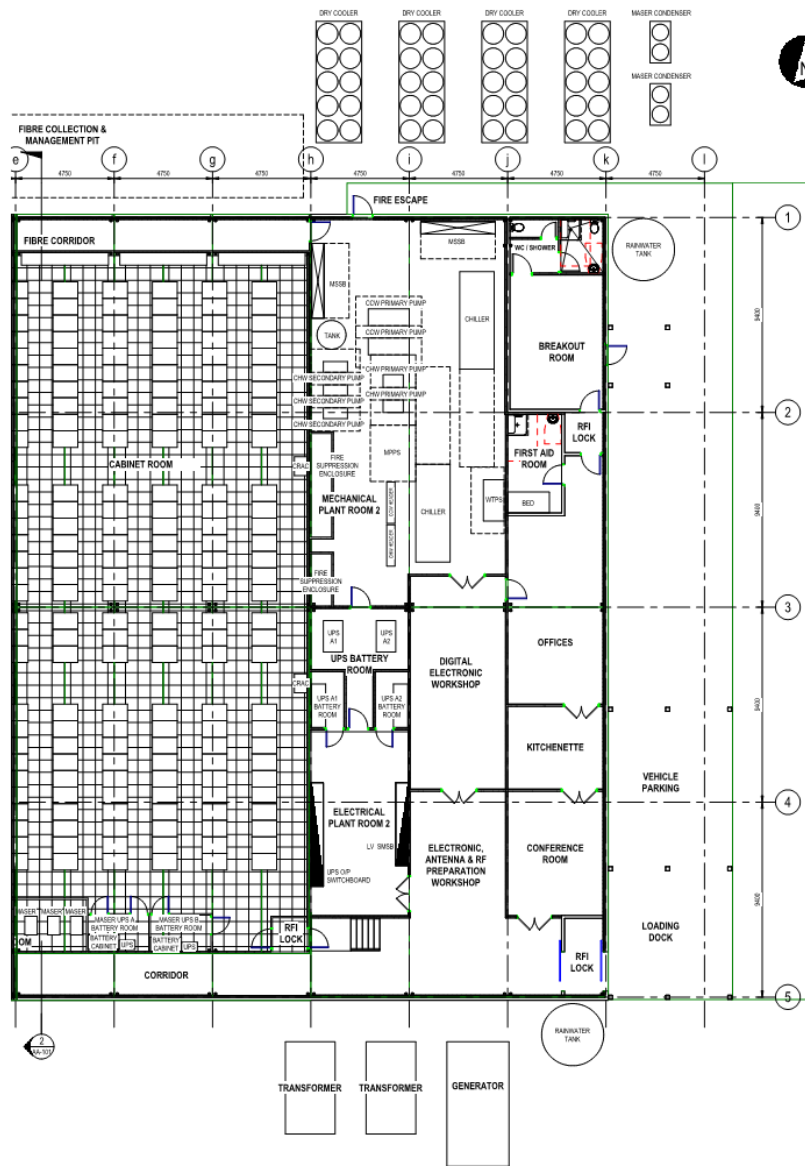
LOW CPF

Element	Cabinets	Comments
LFAA Signal Processing	130	From LFAA ICD (± 5 margin) [AD2]
LFAA Control System	0	Included above From LFAA ICD [AD2]
CSP-Low.CBF	5	From CSP ICD [AD3] amended. Incorporates the CSP-Low.LMC requirements
CSP-Low.PSS	17	From CSP ICD (Range: -0 racks, + 2 racks) [AD3]
CSP-Low.PST	2	From CSP ICD (Range: -0 racks, + 2 racks) [AD3]
TM Low	2	From TM ICD [AD4]
SADT Low	9	From SADT ICD (General racks) [AD5]
SADT Masers	3	From SADT ICD [AD5]
SADT Masers	5	From SADT ICD (Racks supporting the Masers) [AD5]
INAU Control	1	Work in progress estimate
Spares	4	TBC (noting margins above)
Total	180	

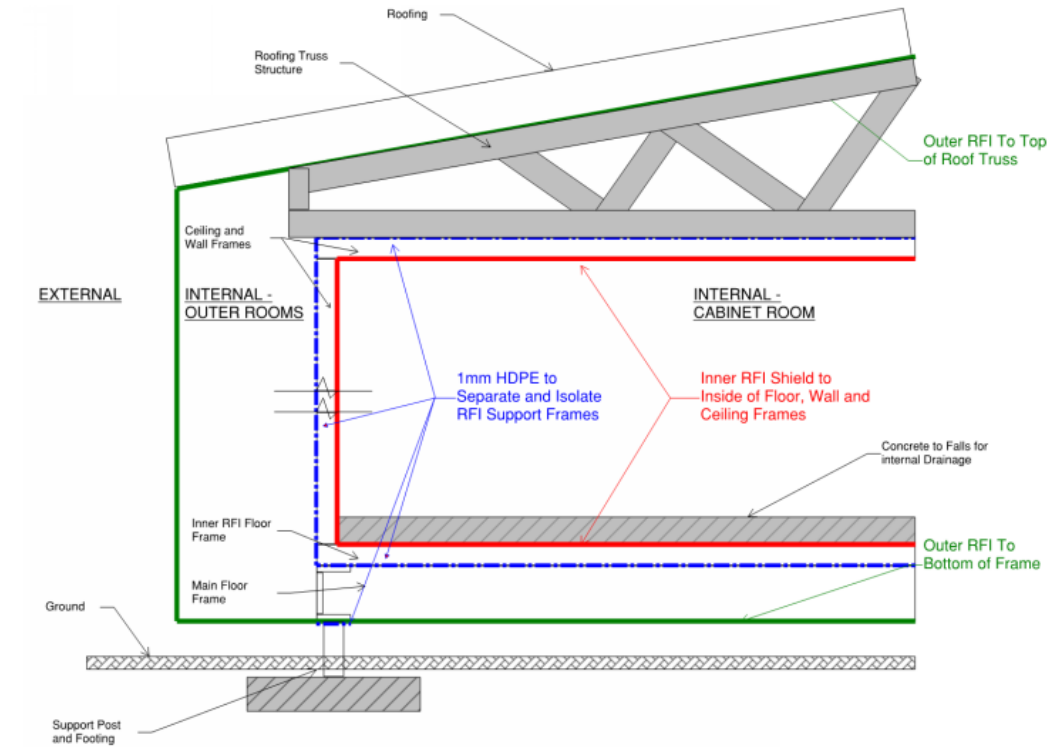
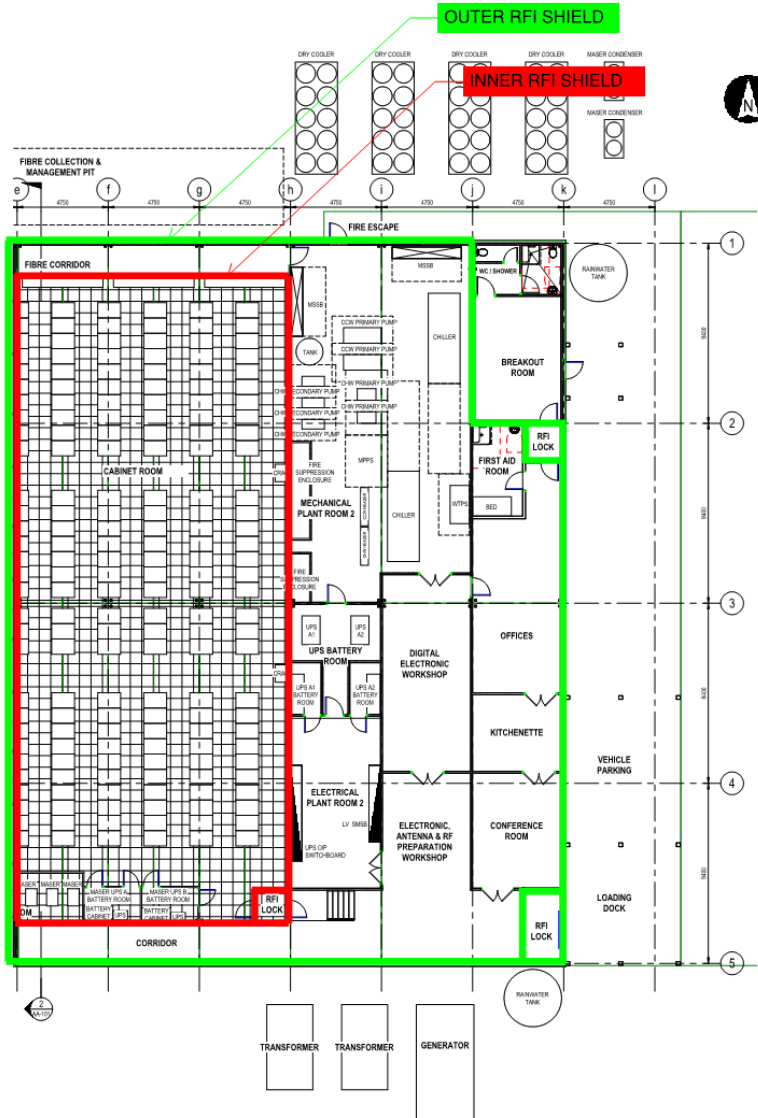
Buildings - SKA1 Low CPF **DRAFT**



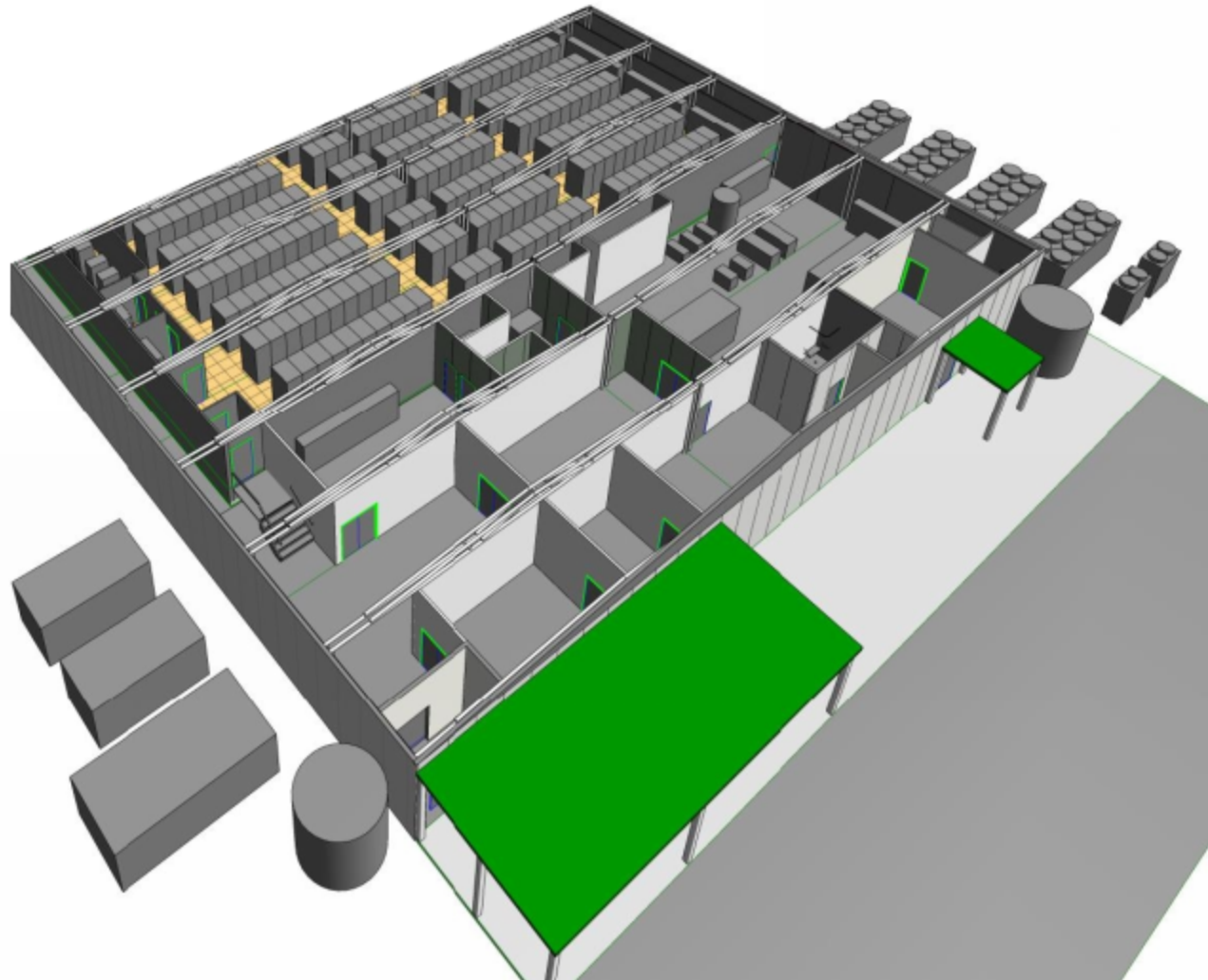
INFRASTRUCTURE AUSTRALIA



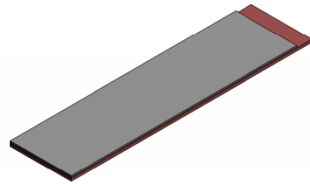
Buildings - SKA1 Low CPF



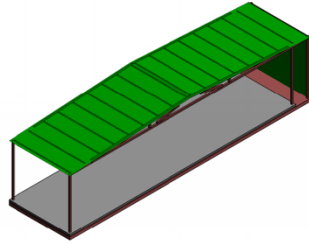
Buildings - SKA1 Low CPF



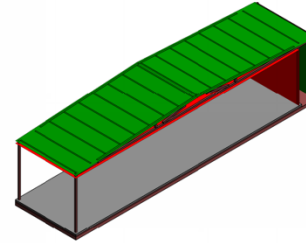
Buildings – Module Buildup



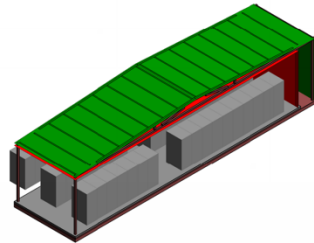
1. MODULE FLOOR



2. MODULE STRUCTURE & OUTER RFI SHIELD



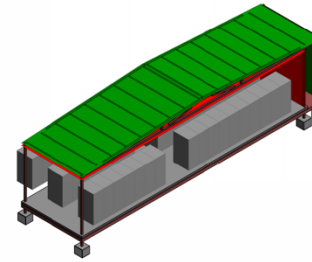
3. MODULE INNER RFI SHIELD



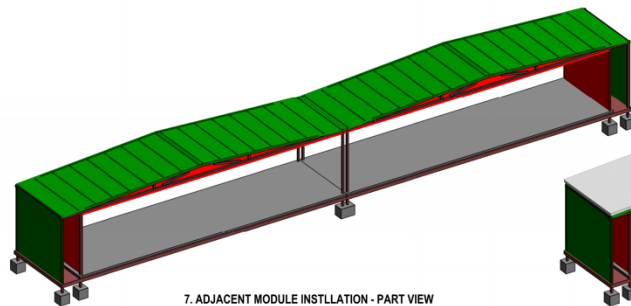
4. MODULE EQUIPMENT
(MODULE NOW READY FOR TRANSPORT TO SITE)



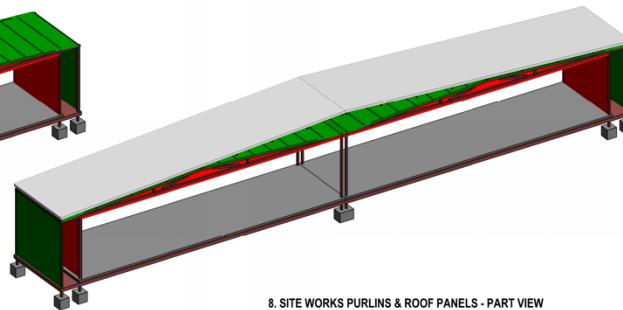
5. SITE WORKS FOOTINGS & STUB COLUMNS



6. MODULE INSTALLATION



7. ADJACENT MODULE INSTLLATION - PART VIEW
(SITE WELD RFI SHIELDS TOGETHER AT MODULE JOINTS)

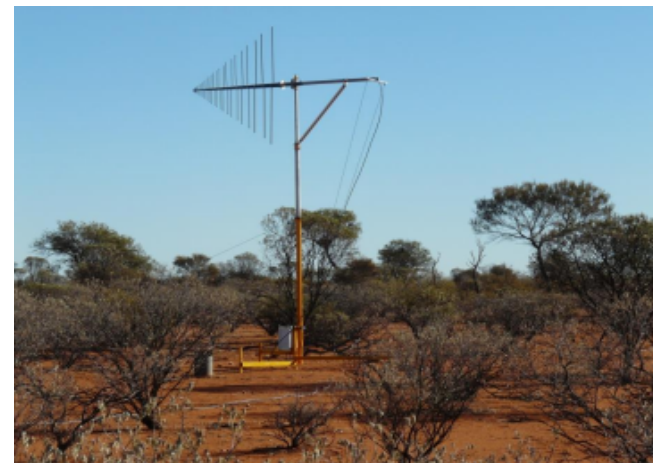
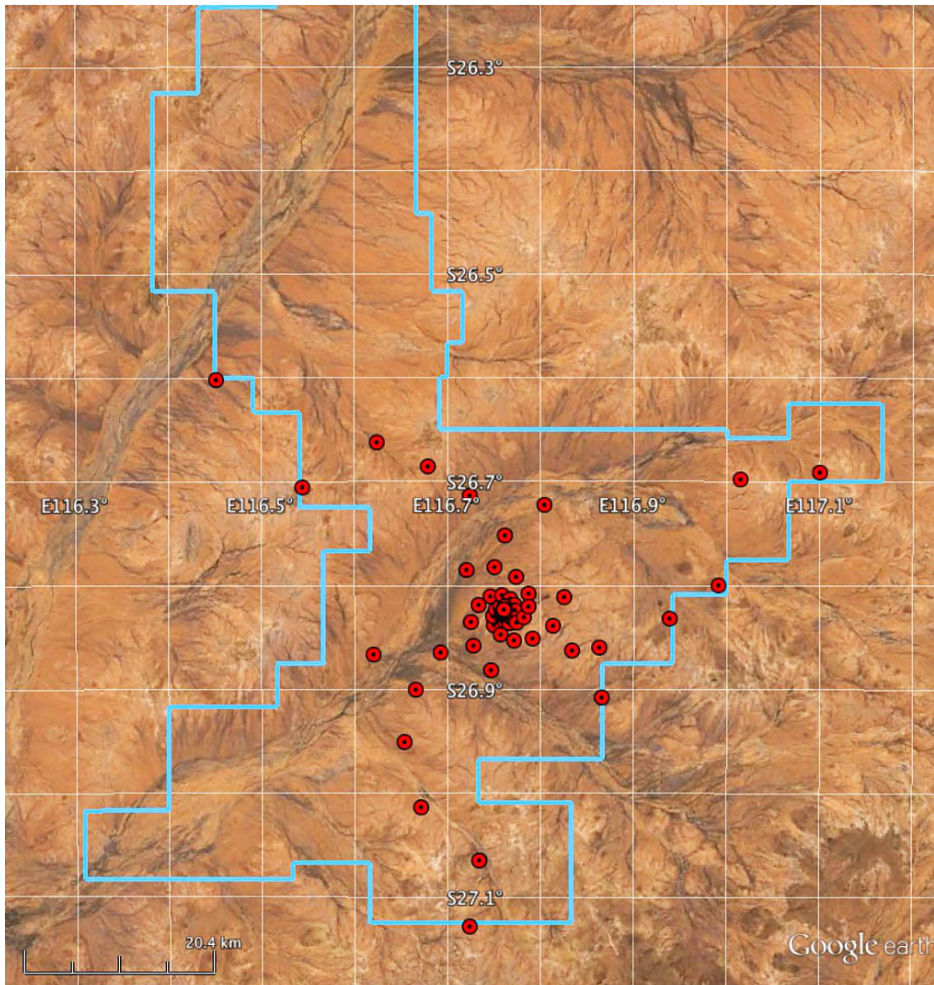


8. SITE WORKS PURLINS & ROOF PANELS - PART VIEW

Site monitoring – PDR concepts



- *Visual, Weather, RFI, Tropospheric, (Lightning)*



RFI:

- 27 meter tower
- 600 m west of ASKAP CPF
- 3 antennas (plan:4)
- Fibre optic connection to CPF

Weather:

- CSIRO design (modified COTS)

Visual:

- Fixed and PZT (minimal)
- CSIRO (modified COTS)
- RFI compliant

Tropospheric:

- Current 2 station unit (near ASKAP)
- 3rd antenna, relocation (?)





Two power working groups established; both chaired by SKAO:

- *Australian Power Strategy Working Group (APSWG), Alistair McPherson*
- *Power Supply Options Workgroup (PSOW), Adriaan Schutte*

APSWG was formed:

- *to explore funding options for the provision of power in Australia, including how to minimize whole of life cost.*
- *members from SKAO, CSIRO, the Department of Industry, Innovation and Science, and the WA Office of Science.*

PSOW group is focussed on :

- *technical aspects*
- *investigate power supply options*
- *covers a broader scope of work (South Africa and Australia).*

*“Prescriptive customer” will NOT produce not cheapest solution
(For INAU, primary power generation is currently out of scope. Small contributions are still made by INAU to inform the above processes.)*

Power Generation – MRO Power Station



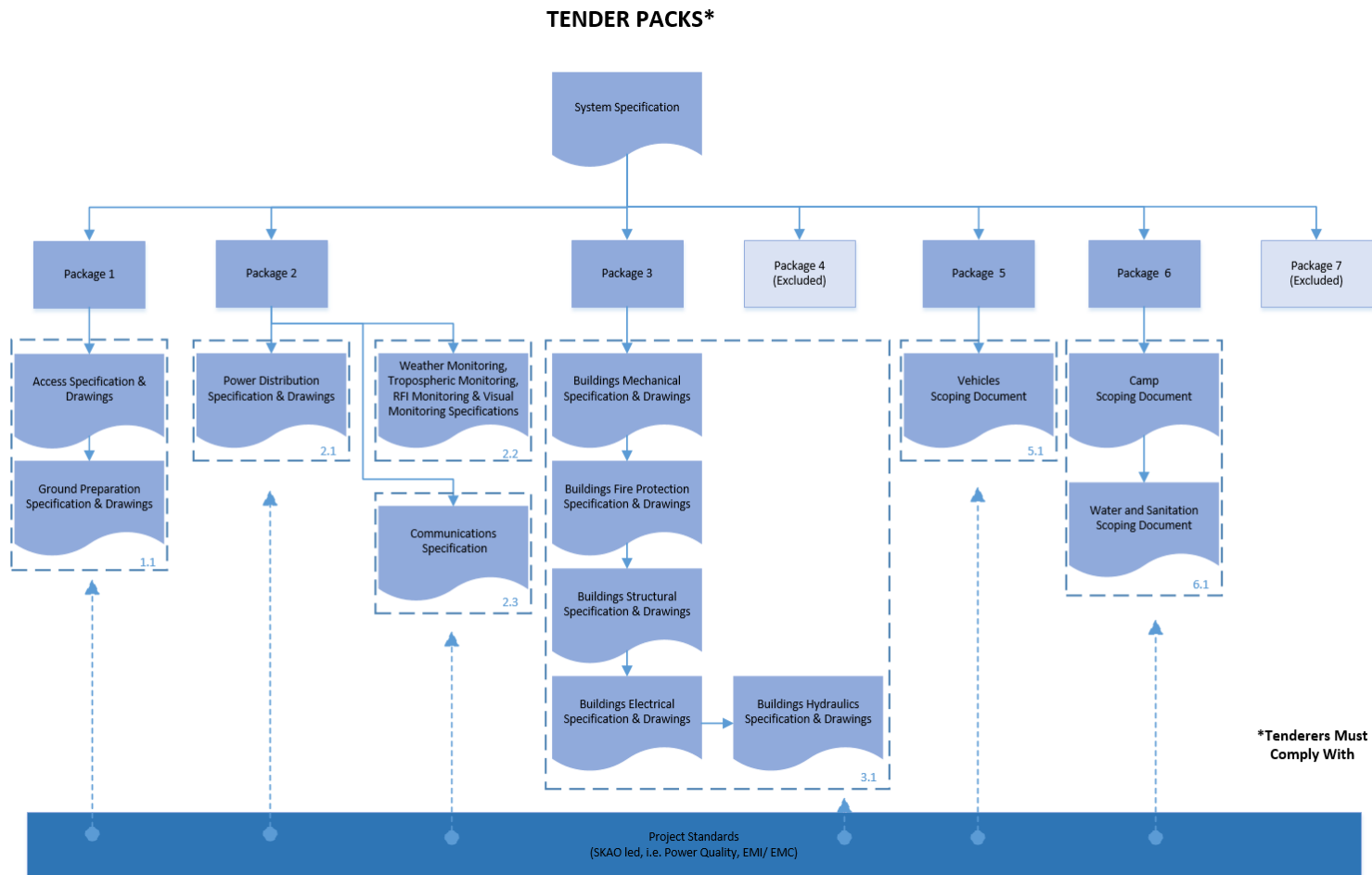
- Horizon Power – Now operational!
 - 4 diesel generators
 - 2 x 240 kW, 2 x 1005 Kw
 - 250 kW solar photovoltaic online
- CSIRO renewable expansion
 - End 2016 integ.
 - Large solar array
 - 5,280 PV panels
 - 1.6 MW peak
 - Very large battery
 - Largest in Australia
 - Lithium ion
 - 2.5 MWh

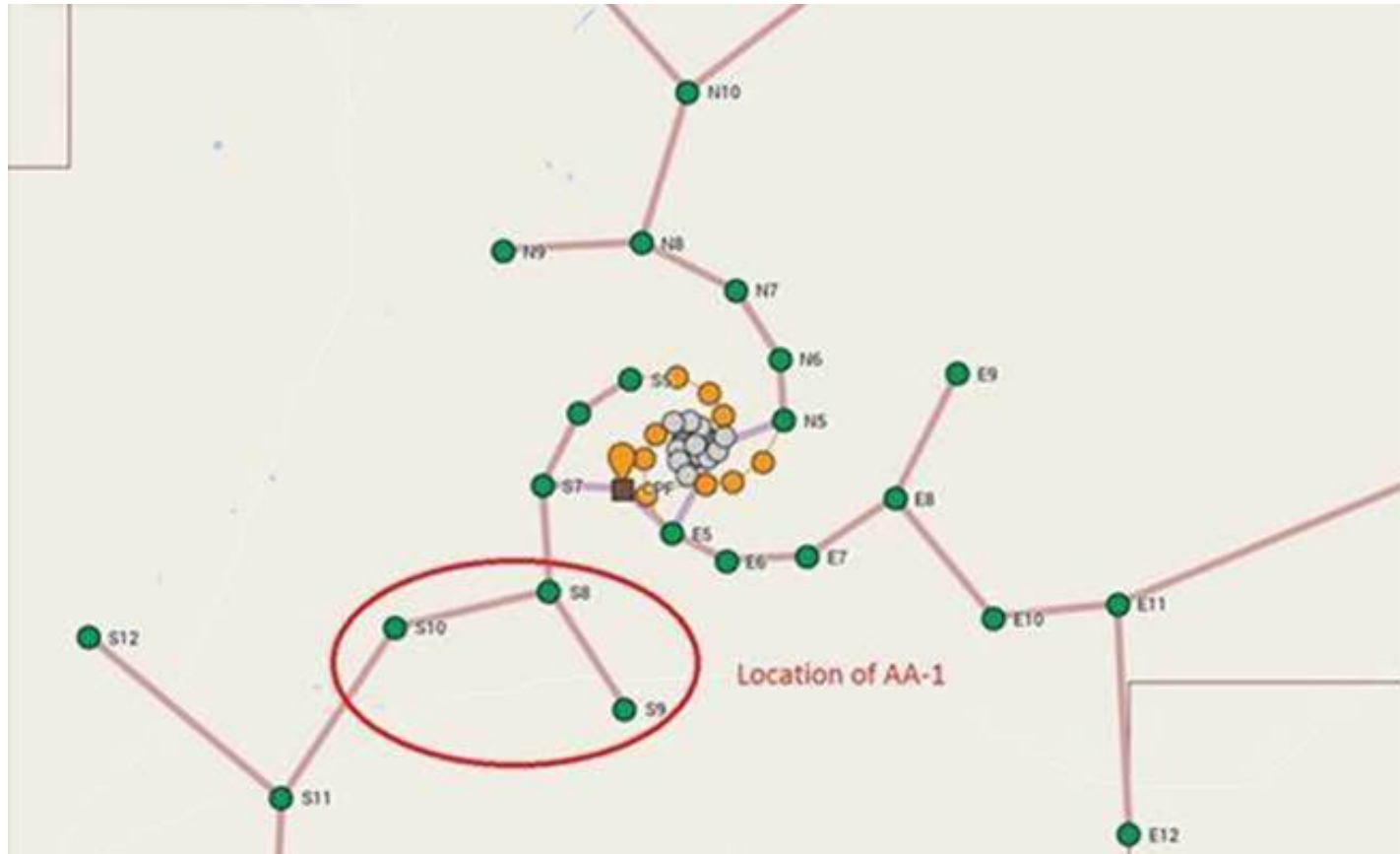




- Introduction
- Who is INAU
- Status
- Milestone progress
- Funding
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- **Towards CDR**
- Issues and opportunities
- Summary

- Three categories – Requirements, Specifications & Drawings, Documents for Information





- Requirement to support early deployments - AA1 etc
- Support with temporary location of RPF (Image Courtesy AIV)



- Introduction
- Who is INAU
- Status
- Milestone progress
- Funding
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- **Issues and opportunities**
- Summary

Issues /Risks

- *Scope Creep*
 - *Work required that is not in budget, but is required, e.g., Pawsey, extra buildings, power generation*
- *Final Low Configuration needed ASAP*
 - *Resolution Team work critical – but may further delay INAU delivery*
- *RFI standards need finalisation*
- *Core Requirements and ICD Completion – schedule (and cost) impacts*
 - *ECP impacts*
- *Geo and hydro survey dependence on heritage process*
- *Operations requirements / standards / model not defined in detail – impacts ?*
- *Program extension will increase the Stage 2 costs*
- *Infrastructure – last to start, first to deliver*

Opportunities

- *Solar power stations for remote outlying Low Stations*
- *Introduction of new member country partners (power solutions)*
- *Whole of Life cost reductions*



- Introduction
- Who is INAU
- Status
- Milestone progress
- Funding
- Key areas of design:
 - Location, core – context
 - Topographical survey and contours
 - Power distribution and solar PV
 - Buildings
 - Site monitoring, Communications
 - (Power generation)
- Towards CDR
- Issues and opportunities
- **Summary**



- *Australian Infrastructure Stage 2 work currently on schedule and budget*
 - *October 2017 CDR under significant pressure !*
- *Major cost items identified and flagged to SKAO*
 - *Working to produce alternatives to high cost drivers*
 - *Power (and fibre) distribution on spiral arms*
 - *RFI implications*
 - *Scope creep*
- *Primary issues:*
 - *Low Configuration*
 - *Scope boundaries*
 - *Lack of definition in other project WPs may cause slippage in Infrastructure schedule (linked to risk of INAU proceeding ahead of confirmed inputs)*
 - *ICD quality / completion inconsistency*
 - *Some policies not agreed yet (e.g. RFI / EMC management, Operations, Maintenance)*

Questions?

