EUROPEAN SPALLATION SOURCE

Engineering and Integration
Update on NBOA

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on behalf of the NSS team

www.europeanspallationsource.se

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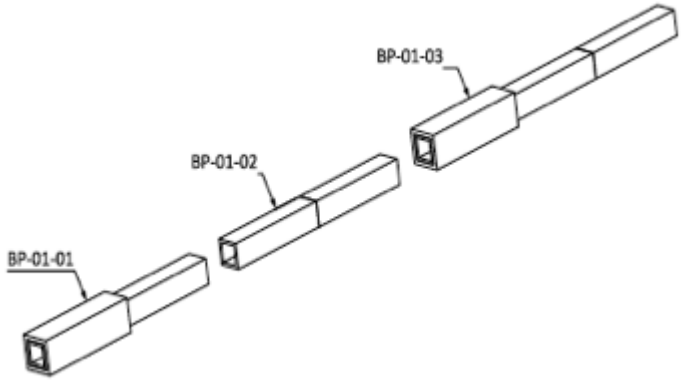
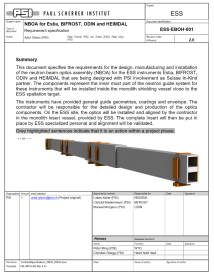


ESS Context – The TG3 tollgate

Relevant Toll gate for NBOA at this stage – TG3 – “Ready for manufacturing”

1) Pre-tender evaluation (or “Pre-TG3”):

- Check of procurement/specification docs and see if they are compliant to ESS needs
- If OK, it is the **go-ahead from ESS for the procurement**.
- This is done before the procurement for the NBOA goes out.
- Tool: TG3 checklist



ESS Context – The TG3 tollgate

TG3 checklist

	REF*	Specification	Reference value	Status	TG3A/B	checked by	Instrument value (if applicable) and/or comment
		BEER	waiting for specs draft				
	NBOA Specifications for TG3 reviews - CHECKLIST			OK	TG3A		
		*Reference document: "NBOA Specifications for TG3 reviews" - ESS_0XXXXXX		NOT OK	TG3B		
				PARTLY OK	TG3A/B		
	REF*	**Specification**	**Reference value**	**Status**	**TG3A/B**	**checked by**	**Instrument value (if applicable) and/or comment**
	ESS NSS	Start of Tendering	before end of Q3/2018				
	ESS NSS	TG3 review before contract signature	2 months before Detailed Design of NBOA				
	ESS TD	Detailed design of NBOA	Q4/2018 (latest Q1/2019)				
	ESS NSS	Delivery of NBOA	15.November 2019				
	4.1.	**General specifications**					
	4.1.1.	Service Life and duty cycles	20 years without degradation effecting performance	PARTLY OK			3.7.4. Lifetime can be discussed. Details tbc
			5 cycles of operation per year are foreseen	OK			3.7.2. (10 duty cycles stated)
	4.1.2.	Maintenance	No maintenance is foreseen. NBOA design has to take this into account	OK			3.7.3.
	4.1.3.	Environmental conditions	Operation phase p.a.: 4000hr	OK			3.7.1.
			Shutdown phase p.a.: 2700hr	OK			3.7.1.
			Installation/logistics/transport phase: up to 6 months	OK			3.7.1.
	4.1.3.1.	Environmental conditions - Temperatures	10° to 60°C nominal operations environment (operation, shutdown)	OK			3.7.1.
			-10 to 30°C nominal environment (installation/logistics/transport)	OK			3.7.1.
	4.1.3.2.	Environmental conditions - Atmospheres	He atmosphere 1.2bar absolute pressure, H2O <60ppm (operation)	OK			3.7.1.
			Normal atmospheric pressure and humidities (installation/logistics/tr.)	OK			3.7.1.
	4.1.3.3.	Environmental conditions - Exposure (radiation)	Neutron capture flux cold: $\Phi = 5 \times 10^{10}$ cm^{-2}s^{-1}	OK			3.7.1.
			Neutron capture flux thermal: $\Phi = 5 \times 10^{10}$ cm^{-2}s^{-1}	OK			3.7.1.
			Neutron capture flux epithermal: $\Phi = 5 \times 10^{10}$ cm^{-2}s^{-1}	OK			3.7.1.
			High energy hadron flux (1MeV-2GeV): $\Phi = 5 \times 10^{12}$ cm^{-2}s^{-1}	OK			3.7.1.
			X-ray to Gamma flux (1KeV-2GeV): $\Phi = 5 \times 10^{12}$ cm^{-2}s^{-1}	OK			3.7.1.
	4.1.4.	Earthquakes: H2/H3 accidental events	Movement <2mm when 2.0g along Neutron beam axis; Functionality at 0.4g	OK			3.3.2.
	4.1.5.	Mechanical integrity of all parts	Maintain integrity and alignment despite fastening degradation/failure	OK			basically covered in 3.3.2.; 3.5.17.
	4.1.6.	Handling	Lifting equipment handling provisions if component >25kg	OK			3.8.1.
			Threaded lifting eyes with appropriate safety features (if any)	OK			3.8.1.
			Provisions are subject to ESS approval (transport, manufacturing)				
			Specific handling tooling is at charge of contractor (if necessary)	OK			3.8.1.
	4.1.7.	Decommissioning, retention	Sectioning of NBEX at decommissioning has to be taken into account	OK			3.5.18.
	4.2.	**Guides**					
	4.2.1.	Flatness and waviness	Angle btw surface normals: within cone of semi-angle $\alpha < 2.0 \times 10^{-4}$ radian RMS	OK			3.5.4.
			Max. peak value of acceptance is $\alpha < 5.0 \times 10^{-4}$ radian RMS at any point	OK			3.5.4.
	4.2.2.	Coatings	Minimum m-values + reflectivities for each coated surface inside NBOA	OK			3.9.2.
			Type Ni/Ti Super-mirror	OK			3.5.12.

TEMPLATE | MIRACLES | FREIA | NMX | C-SPEC | LOKI | BIFROST ODIN HEIMDAL ESTIA | BEER | MAGIC | DREAM | VESPA | T-REX | SKADI

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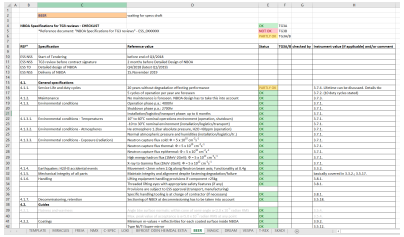
- Tool: TG3 checklist

2) TG3 Part 1 (or "TG3A"):

- Check if selected proposal of contractor is compliant to ESS needs
- If OK, it is the **go-ahead from ESS for the Detailed Design Phase**
- Usually done at kick-off meeting with the manufacturer
- Tool: TG3 checklist



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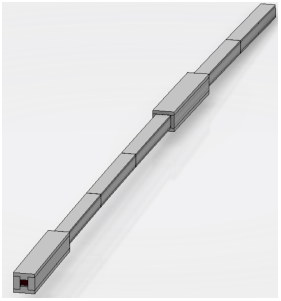
- Usually done at kick-off meeting with the manufacturer
- Tool: TG3 checklist

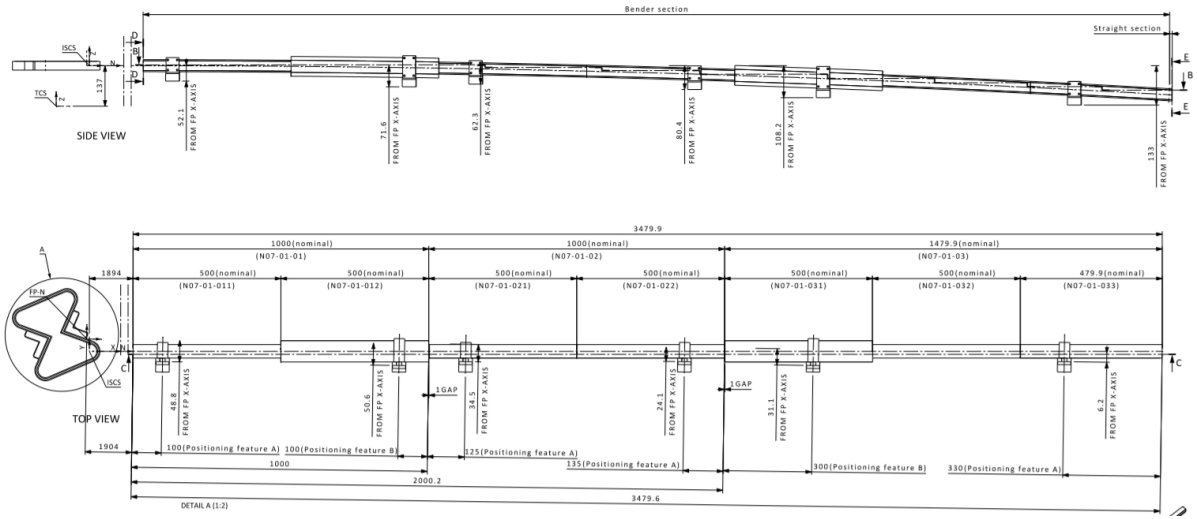
3) TG3 Part 2 (or "TG3B"):
- Check if the developed design of the supplier is compliant to ESS needs
- If OK, it is the **go-ahead from ESS for the Manufacturing process**
- Usually done just before/during the Final Design Review of the Detailed Design
- Tool: Extended TG3 checklist + Instrument-specific checks

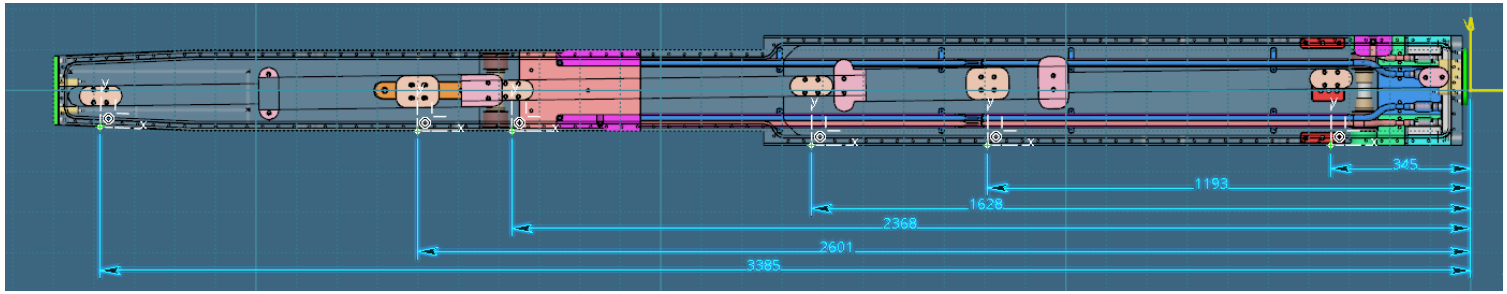


ESS Context – The TG3 tollgate

Instrument-specific checks

Will mainly be used for checking compatibility between instrument NBOA model (by manufacturer) and the respective instrument NBPI model (by Target Division). Although there are common features for all NBOA/NBPI interfaces, they might differ from each other considerably.





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- Tool: TG3 checklist

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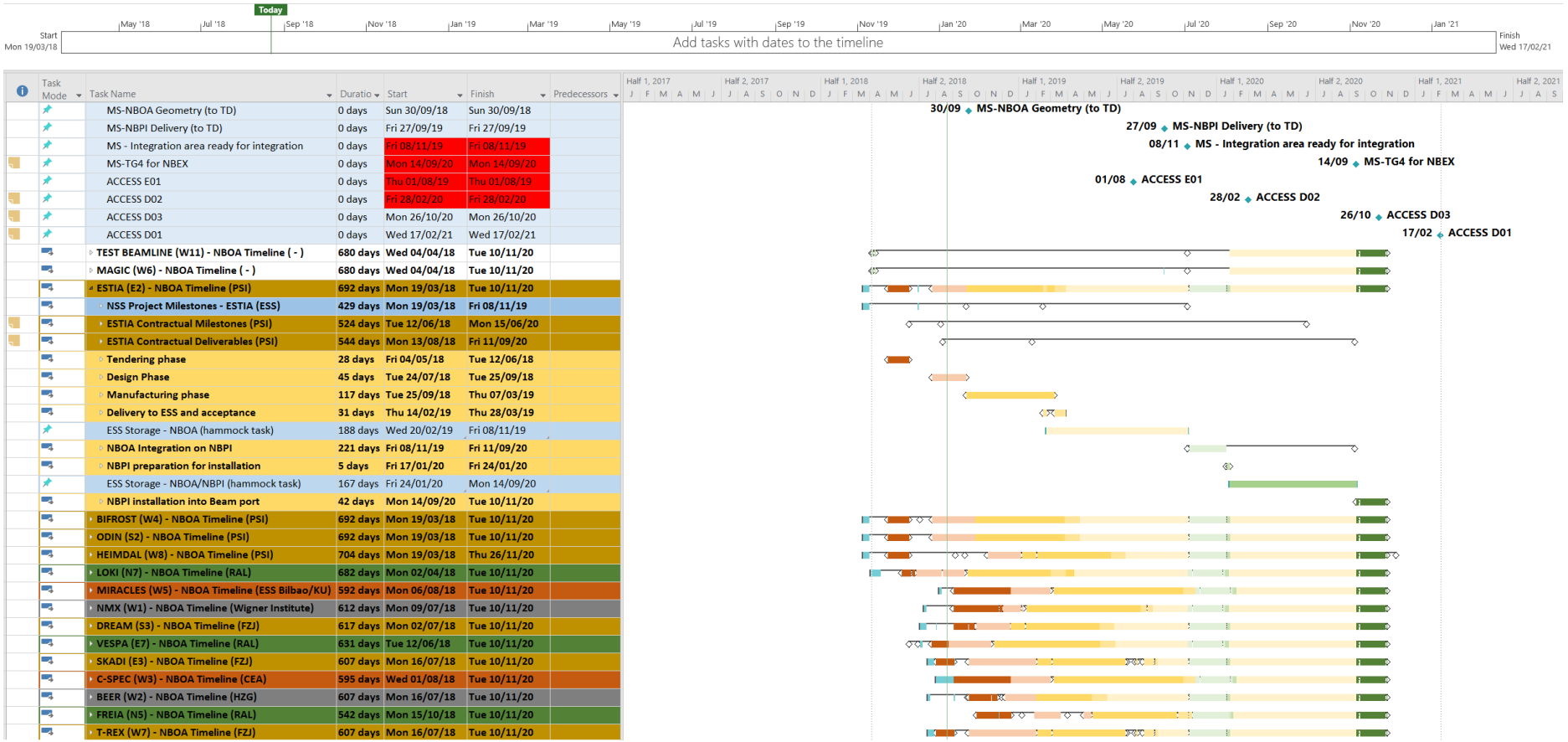
- Check if the developed design of the supplier is compliant to ESS needs
- If OK, it is the **go-ahead from ESS for the Manufacturing process**
- Usually done just before/during the Final Design Review of the Detailed Design
- Tool: Extended TG3 checklist + Instrument-specific checks

"Phase 3"

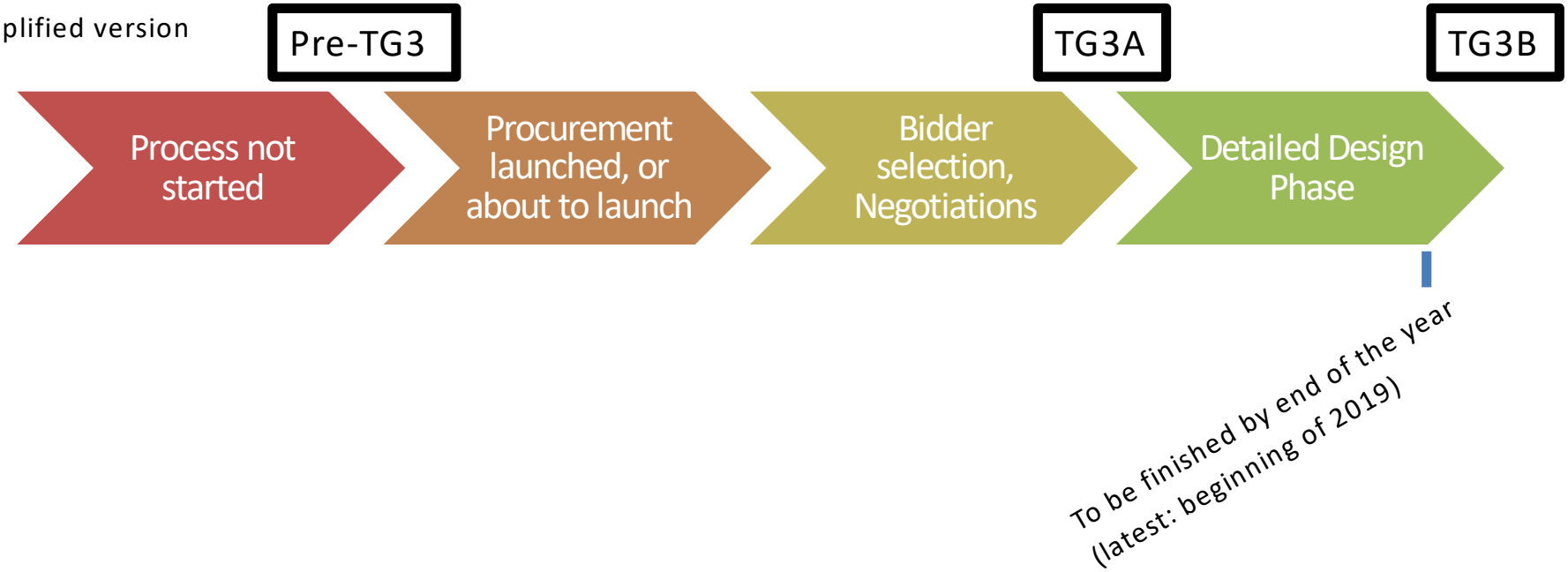
Status of NBOA procurements

Formal version

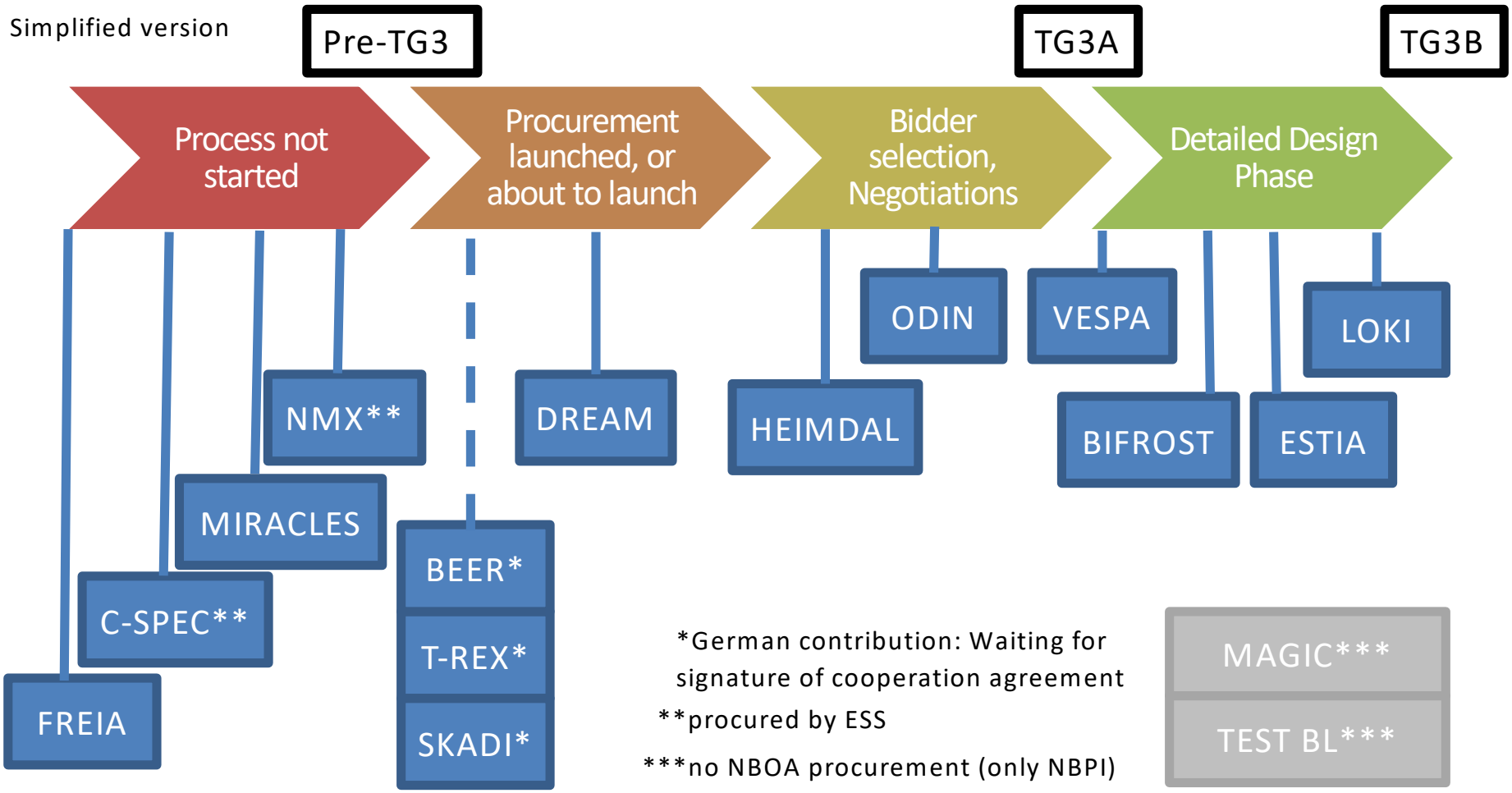


Status of NBOA procurements

Simplified version



Status of NBOA procurements



ESS Context – The TG4 tollgate

Relevant Toll gate for NBOA in medium/long term – TG4 – "Instrument installation/cold commissioning"

1) Factory acceptance test (FAT):

- Check of component/assembly quality and acceptance of parts
- If OK, it is the **go-ahead from ESS for delivery to ESS site**
- This is usually done after completion of manufacturing
- Tool: Quality control documents/checklist

2) Site acceptance check:

- Check of delivered assemblies for defects, damages
- If OK, it is the **go-ahead from ESS for storage (if applicable)**
- Done after delivery to ESS site
- Tool: Visual control

ESS Context – The TG4 tollgate

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1) Factory acceptance test (FAT):

- Check of component/assembly quality and acceptance of parts
- If OK, it is the **go-ahead from ESS for delivery to ESS site**
- This is usually done after completion of manufacturing
- Tool: Quality control documents/checklist

2) Site acceptance check:

- Check of delivered assemblies for defects, damages
- If OK, it is the **go-ahead from ESS for storage (if applicable)**
- Done after delivery to ESS site
- Tool: Visual control

3) Integration readiness check (ESS-internal)

- Check if all documents/procedures are complete and all resources are available
- If OK, it is the **go-ahead from ESS for NBOA integration**
- Done 1-3 weeks before planned integration date
- Tool: Checklist

ESS Context – The TG4 tollgate

Relevant Toll gate for NBOA in medium/long term – TG4 – "Instrument installation/cold commissioning"

1) Factory acceptance test (FAT):
- Check of component/assembly quality and acceptance of parts
- If OK, it is the **go-ahead from ESS for delivery to ESS site**
- This is usually done after completion of manufacturing
- Tool: Quality control documents/checklist

2) Site acceptance check:
- Check of delivered assemblies for defects, damages
- If OK, it is the **go-ahead from ESS for storage (if applicable)**
- Done after delivery to ESS site
- Tool: Visual control

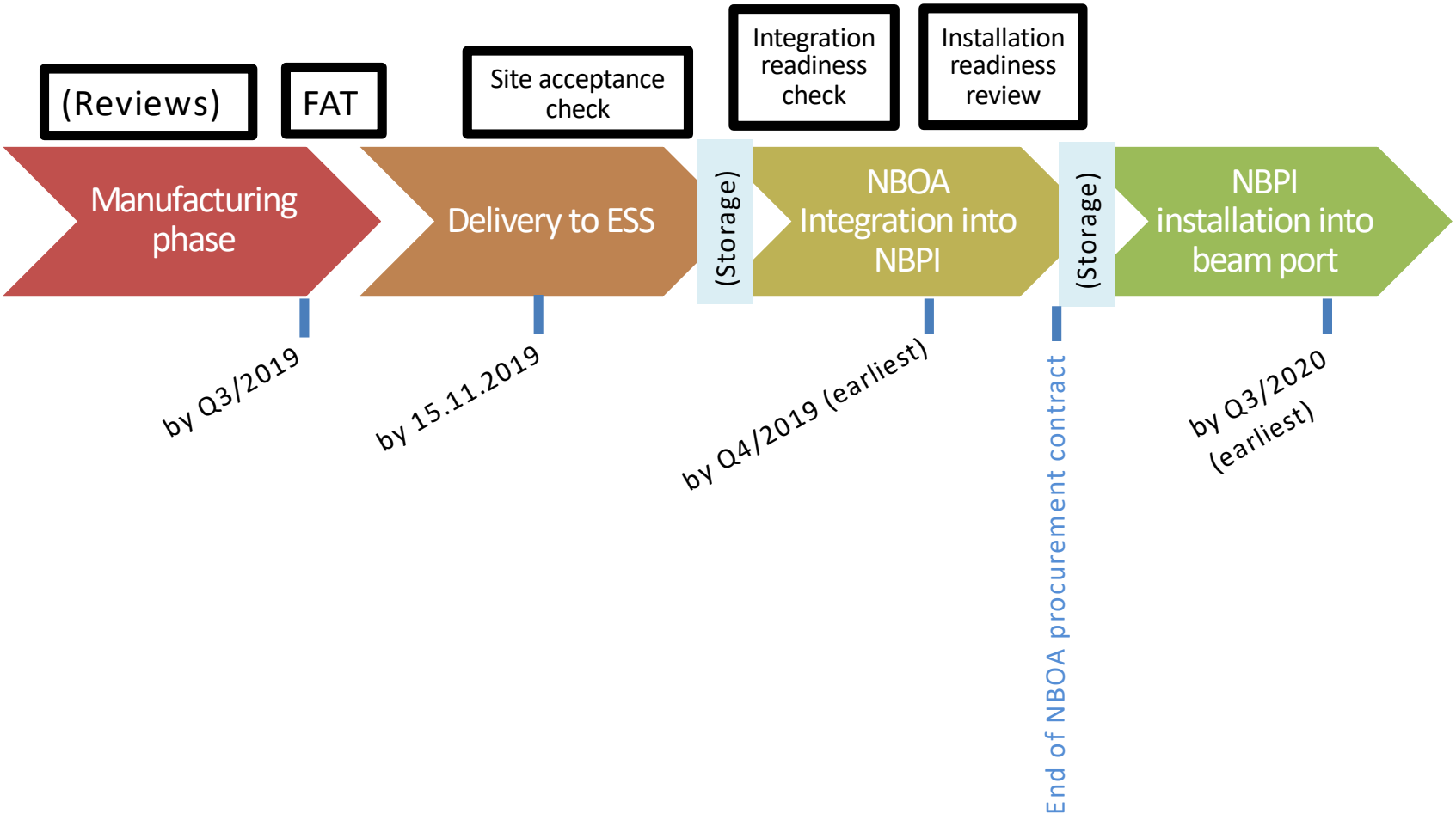
3) Integration readiness check (ESS-internal)
- Check if all documents/procedures are complete and all resources are available
- If OK, it is the **go-ahead from ESS for NBOA integration**
- Done 1-3 weeks before planned integration date
- Tool: Checklist

4) Installation readiness review (IRR):
- Check of proper alignment/adjustment of NBOA within NBPI
- If OK, it is the **go-ahead from ESS for NBEX installation into beam port**
- Done after alignment/adjustment of NBOA within NBPI
- Tool: Checklist, survey protocols

"Phase 4"

Rough timeline until installation

Simplified version



Summary

Short term

- TG3 tollgate (end of ESS Phase 3) corresponds to “OK for NBOA manufacturing”
- Frequent ESS checks are in place during Phase 3 to ensure compatibility to ESS requirements and interfaces
- All NBOAs are expected to be ready for manufacturing by the end of Q1/2019 latest (end of “Detailed Design Phase”)

Medium/Long term

- ESS Phase 4 includes NBOA manufacturing and integration into NBPI
- The installation readiness review will conclude the NBOA procurement contracts
- All NBOAs are expected to be at ESS by November 2019 and ready for integration by the end of the year
- Installation into experiment is expected by Q3/2020 (tbc)

Thank you for your attention!

Questions?

IN THE COURSE OF THE EVOLUTION, BOA CONSTRICTORS FOUND NEW HUNTING STRATEGIES.

Backup slides

TG3 checklist - content

REF*	Specification	Reference value
ESS NSS	Start of Tendering	before end of Q3/2018
ESS NSS	TG3 review before contract signature	2 months before Detailed Design of NBOA
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ESS NSS	Delivery of NBOA	15.November 2019
4.1.	**General specifications**	
4.1.1.	Service Life and duty cycles	20 years without degradation effecting performance
		5 cycles of operation per year are foreseen
4.1.2.	Maintenance	No maintenance is foreseen. NBOA design has to take this into account
4.1.3.	Environmental conditions	Operation phase p.a.: 4000hr
		Shutdown phase p.a.: 2700hr
		Installation/logistics/transport phase: up to 6 months
4.1.3.1.	Environmental conditions - Temperatures	10° to 60°C nominal operations environment (operation, shutdown)
		-10 to 30°C nominal environment (installation/logistics/transport)
4.1.3.2.	Environmental conditions - Atmospheres	He atmosphere 1.2bar absolute pressure, H2O <60ppm (operation)
		Normal atmospheric pressure and humidities (installation/logistics/tr.)
4.1.3.3.	Environmental conditions - Exposure (radiation)	Neutron capture flux cold: $\Phi = 5 \times 10^{10}$ $cm^{-2}s^{-1}$
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4.1.4.	Earthquakes: H2/H3 accidental events	Movement <2mm when 2.0g along Neutron beam axis; Functionality at 0.4g
4.1.5.	Mechanical integrity of all parts	Maintain integrity and alignment despite fastening degradation/failure
4.1.6.	Handling	Lifting equipment handling provisions if component >25kg
		Threaded lifting eyes with appropriate safety features (if any)
		Provisions are subject to ESS approval (transport, manufacturing)
		Specific handling tooling is at charge of contractor (if necessary)
4.1.7.	Decommissioning, retention	Sectioning of NBEX at decommissioning has to be taken into account
4.2.	**Guides**	
4.2.1.	Flatness and waviness	Angle btw surface normals: within cone of semi-angle $\alpha < 2.0 \times 10^{-4}$ radian RMS
		Max. peak value of acceptance is $\alpha < 5.0 \times 10^{-4}$ radian RMS at any point
4.2.2.	Coatings	Minimum m-values + reflectivities for each coated surface inside NBOA
		Type Ni/Ti Super-mirror
		Reflectivity profile according to provided characteristics curve (see reference)
		Scratches, greyness, open bubbles, scuff marks and other defects <0.02% area
		Cumulative surface of cracks/chips on chamfers <5% of edge surface
4.2.3.	Geometrical information (drawing)	Overall length, width, height of all NBOA units

TG3 checklist - content

4.2.3.	Geometrical information (drawing)	Overall length, width, height of all NBOA units
		Representative cross section(s) and specific profiles, if applicable
		Gaps between units (nominal: 1mm)
		Curvature(s) of units and their tolerances to nominal (instrument-dependent)
		Focal point location and NBOA orientation
		Wall thickness(es) of substrate
4.2.4.	Fabrication tolerances (geometry, distances)	Super-mirror surface +/- 0.02mm relative to true taper profile (full assembly!)
4.2.5.1.	Guide alignment	0.05mm relative adjustment of guide units to each other (x,y,z)
		Unit alignment +/-0.01mm i.r.t. true position of theoretical beam line center
4.2.5.2.	Alignment reflector interfaces	Provisions for alignment devices (laser reflectors), proposed by contractor
		Alignment features shall allow positioning/orientation of each unit +/-0.05mm
4.2.5.3.	Alignment plan	An alignment plan shall be developed during design process, for approval
4.2.5.4.	Alignment marks (for visual pre-alignment/verification)	Tolerance: +/-0.01mm deviation from nominal position
		Shall be visible by naked human eye at distance of 1m.
		Shall be visible during the complete lifetime of the guide
		3 marks on front and rear respectively (2 for height, 1 for width)
4.3.	**Shielding**	placed in 2 particular locations around Unit 01 and Unit 03
		gapless (tbc) contact with coated substrates, or out of same material chunk
		Loads placed on jackets/substrates shall not deform coated surfaces (value tbd)
		Length and cross section must be specified within tolerance
		Step i.r.t. to substrate: min 13mm (15mm if substrate thickness is <8mm)
4.4.	**Support fixtures**	kinematic system (no over-constraint - except "soft over-constraint" via springs)
		Positioners shall be rigid and placed on side and bottom of each unit
		Springs to be placed opposite of each positioner
		Positive locking
		Shall permit compensation for thermal expansion whilst retain alignment
		Minimum adjustment range +/- 2mm i.r.t. nominal position
4.5.	**Materials**	Substrates -- High purity copper (EN CW008A, DIN 2.40-CuOF, UNS C10100)
		Shielding -- High purity copper (EN CW008A, DIN 2.40-CuOF, UNS C10100)
		Coating -- Nickel/Titanium
		Separators -- Silicon
		Fixations, springs, etc. -- Stainless Steel 316L
		Positioning -- see materials list "allowed for general construction" (see reference)
5.1.	Scope of work	Definition according to TG3 framework (reference)
5.2.	ESS-specific requirements	ESS Safety regulations must be taken into account
		Swedish regulations (Swedish Nuclear Authorities) must be taken into account
		Provisions for working on ESS site must be considered (access, taxes, insurance, etc)
5.3.	Unified nomenclature of components	Units--Functional groups (Neutron optics, Shielding, Support fixtures)
5.4.	Warranty (see reference)	Standard warranty period: 5 years after SAT, or

TG3 checklist - content

5.4.	Warranty (see reference)	Standard warranty period: 5 years after SAT, or
		2 years following first exposure to neutrons, or
		Total neutron exposure corresponding to 50GWh proton BoT
		Neutron dose guide entrance: 2×10^{20} cm^{-2}
		Warranty due if degradation of components >10% w.r.t. original measured values
5.5.	Changes and non-conformities	Change request, non-conformance report must be applied (ESS-0008702)
5.6.	Intellectual property	(if applicable - appropriate procedures must be applied)
5.7.	CE conformance	(if applicable - according to ESS-0127031, or institute guidelines)
5.8.	Materials certification	Certification according to EN 10204 ref. type 3.1.
		ESS reserves right to test each individual component with non-destructive methods
5.9.	FAT, SAT, Delivery to site	According to pre-defined processes
5.10.	Project management requirements	According to pre-defined processes (ISO 9001, or comparable)
5.11.	Responsible persons for communication	Persons for technical, contractual matters must be outlined
		Ability to speak English in a professional context is mandatory
5.12.	Subcontractors	Subcontractor involvement must be outlined in bid
		If not explicitely excluded, same standards apply for project MGMT, QA, etc.
5.13.	Access to (sub-)contractors premises	Access shall be possible by ESS representatives for audits or reviews
5.14.	Quality assurance	w.r.t. ISO 9001. Additional rules according to former agreement with institutes
5.15.	Labeling of products	Manufacturer name, ID, serial number (if applicable)
		Origin of connecting elements with material information must be available
5.16.	Delivery dates - Project plan - Milestones	Must be agreed upon latest at kick-off meeting with ESS/institute representatives
5.17.	Contractually agreed cost	Procedure in case cost is exceeded must exist/must be applied
		Procedure for order/specs change must exist/must be applied
5.18.	Applicable ESS reference documents	Project quality plan - ESS-0037830
		Target quality plan - ESS-0027134
		ESS rules for Quality regulation for mechanical equipment - ESS-0047989
		ESS rules for CE marking - ESS-0127031
		ESS procedure for Mechanical Engineering Design - ESS-0002411
		Guidelines for accessing and performing work on site - ESS-0147089
5.19.	Handling, packing and transport of products	Must allow unpacking with standard tools (knives, scissors, wrenches, etc.)
		Fragility, stacking orientation, damage hazards (if applicable) must be indicated
		Packing cases must be stout and robust, suitable for lifting/transportation
		Weight/size of box, content, sender adress must be written on the enclosure