

Preliminary market consultation PF coils for COMPASS-U

questions and notes

v. 1.1

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Tender and **Contract** specifics

1. Time limit for the tender Bid

- IPP plans to issue a **45-day** notice for the preparation and submission of the bid.
Is that adequate for your bid preparation?

note: The tendering company can raise official request to **prolong time limit** during time period for the bid through layer attorney responsible for tender or through website Tenderarena.cz. IPP can either accept or reject the request.

2. Tender type and Price cap

- IPP plans to launch the tender as a framework purchase agreement with total **price limit of 2.8 MEUR** without VAT. **Will you submit the bid?**

Framework agreement:

Item 1 = basic configuration

order obligatory, delivery **deadline 24 months** (coil acceptance tests at IPP premises)

- 10 PF coils, 1 prototype coil
- Insulation samples, 3x3 mock-up, material tests and qualifications, coil tests, transport
- Tests include Full paschen test of prototype coil, Local Paschen tests of all 10 PF coils

Item 2 = 8x Paschen test of smaller coils

2xPF1a, 2xPF1b, 2xPF2, 2xPF3, order optional, deadline of chosen coil **prolonged by 2 months**

Item 3 = 2x Paschen test of larger coils

2xPF4, order optional, deadline of chosen coil **prolonged by 2 months**

3. Paschen tests

Any questions/comments regarding Paschen tests?

there are two types of Paschen tests in tender:

Local Paschen

- Test of coil **coolant and current feeder areas** – mandatory for all coils (except of prototype coil).
- The manufacturer can choose full (surface coverage) Paschen test instead.
- Does not require large vacuum chamber but requires to create ad-hoc vacuum tight chamber/bag around the tested coil areas.

Full surface coverage Paschen

- Test of the **whole coil** – mandatory for prototype coil, subject of additional order by IPP for the rest of the coils (items 2 and 3 in Framework Purchase Agreement).
- Can be conducted as a **series of local Paschen tests** covering the whole coil surface or **Paschen test of the whole coil + feeders in one go** (requires large enough vacuum chamber)

The deadline for IPP to order the Full surface coverage Paschen tests is **16 months**.

4. Advance payments

IPP proposes the following advance payments:

1. **10 % of the Purchase Price** of Basic Configuration excl. VAT
after the Order of Basic Configuration is accepted (i.e. = start of contract)
2. **5 % of the Purchase Price** of Basic Configuration excl. VAT
after acceptance of "MIT plan initial version" by IPP (i.e. = manufacture plan delivered)
3. **10 % of the Purchase Price** of Basic Configuration excl. VAT
after the manufacturer stacks > 75 % of conductor for production of coils
4. **25% of the Purchase price** of Basic Configuration excl. VAT
after successful FAT of prototype coil (factory acceptance tests)

Do you agree with these advance payments?

5. Technical qualification

At least **1 important supply** in the last 10 years before the tender release date (i.e. 2015+):

What is important supply?

Coil/coils with median diameter $d > 0.5$ m for **fusion, particle accelerator** or **high magnetic field** ($B \geq 2$ T)

Moreover, **important supply/supplies** have to **fulfill all** of the following **requirements**:

(cumulatively, it is not necessary that each supply fulfils all requirements)

1. Coil (coils) manufactured from **copper profile** or using **CIC** (cable in conduit) technology in **total price greater than 600,000 EUR**. (not additively by multiple supplies)
2. Use of coil insulation materials **suitable for vacuum** ($< 10^{-2}$ Pa, within range of high vacuum)
3. Coil insulated using **vacuum pressure impregnation** process.

Note: Important supplies where tendering company was part of a consortium can be accepted, if the key coil manufacture steps (winding, taping, VPI and curing) were made by the tendering company

Can you meet the qualification?

6. Project manager

IPP requires the tendering company to **provide a project manager** responsible for the **management of technical processes** related to the delivery of the contracted items.

The project manager has to have the **following experience**:

- at least **1 participation** as a member of a project implementation team in a successfully completed contract for **manufacturing of a copper or a superconductive coil** (coils) for **nuclear fusion / particle accelerators / high magnetic field** ($B \geq 2$ T).
The total price of the contract has to be no less than **100,000 EUR**
- at least **1 participation** as a "Project Manager" in a successfully completed contract in the amount no less than **100,000 EUR**.

Can you meet the qualification?

7. Contractual Penalties

In the contract, the following penalties are specified (pct from purchase price of Basic configuration):

- **0.010% daily** penalty (cap 1%) for delay of delivery of MIT plan (refundable if Basic configuration on time)
- **0.003% daily** penalty (cap 0.5%) for delay of 3x3 mock-up FAT (refundable if Basic configuration on time)
- **0.010% daily** penalty (cap 1%) for delay of prototype coil FAT (refundable if Basic configuration on time)
- **0.035% daily** penalty (no cap) for delay in delivery of Basic configuration
- **0.010% daily** penalty (cap 2%) for delay in removal of defects of delivered items
- Penalties related to critical activities (see later)
 - EUR 200 per level 1 breach, EUR 1000 per level 2 breach, EUR 1000 per level 3 breach
- **10% one-time** penalty for **non-delivery** of Basic Configuration (+ refund all advance payments)
- Total aggregate cap on penalties is 10%

Will you submit the bid?

8. Critical activities

Specific penalties specified by severity of violation of critical activities.

incident level 3 => IPP has the right to **request new manufacture** of an item or to **terminate the Contract**

- **Cleanliness regulations**
 - clean room, material handling, material protection rules
- **Rules for selection, properties, testing and validation of materials used for manufacturing**
 - use of non-conforming materials is always incident level 3
- **Photo & video documentation**
 - key manufacture steps have to be photo & video documented (live stream available to IPP)
 - video documentation plan has to be submitted to IPP prior to these activities
- **Witness points / Hold points**
 - **witness points** = Manufacturer has to notify IPP prior to listed key activities and allow presence of IPP staff to observe.
 - **hold points** = Manufacturer is not allowed to proceed with certain manufacturing activities unless conditions are met (i.e. coils manufacture cannot start without approved MIT plan)

9. Storage and shipment

- The Manufacturer is obliged to **safely store at his own expense on his premises** any coils that have already passed FAT (Factory acceptance tests) until the **last of the coils passes FAT** + additional 30 calendar days.
- Once all coils passed FAT (=obtained transport permission), the Manufacturer will transport them (including sectioned prototype coil) in a **maximum of 4 shipments** to IPP's address.
- IPP can request some coils (after passing FAT) to be shipped earlier, these shipments will not be counted in the 4 aforementioned shipments.
- **Transport** to IPP will be carried out at the **Manufacturer's costs and responsibility**.
- The **coils will be accepted by IPP after passing SAT** (Site acceptance tests) at IPP premises after delivery (confirmed by signing Handover Protocol of Acceptance).

Do you agree with these conditions?

10. Other

- Manufacturers located **outside the EU** are **responsible for any tolls incurred**
- The **Intercom regulations do not apply** to the acceptance of this product. IPP defines its **own regulations that apply for PF tender.**
- **Termination of the contract** is in regime **ex nunc** (from now); there are 22 partial fulfillments: MIT plan, 1x prototype coil, 10x coil, 10x Paschen test
 - **No mutual damages** (few exceptions, i.e. refunding trip on witness point which failed or did not happen; if we terminate the contract due to the grant being cancelled)
- **Do you agree with these conditions?**
- **Is your company capable of signing contracts electronically?**

Remaining design questions

1. PF coils conductor bending

- Conductor will be made of **CuAg0.10(OF)** according to EN CW019A or equivalent.
- Conductor cross-sectional area dimensions (PF1-PF3 coils) are 14.7 x 15 mm with a 7 mm diameter circular cooling hole.
- Required material condition is **R290** (= min. **250 MPa yield strength** at 20°C).
- **Elongation at break** for such a hard copper can be quite low.
- We are worried about **small radius bends** (i.e. coil feeders 90° bends). **Bending tests** of conductor samples are **required**.

Note that compromise of conductor yield strength (i.e. lowering below 250 MPa) is not allowed. Local annealing is therefore probably not an option. The option might be bending at cryogenic temperature (greatly increased elongation at break)

Are you capable to submit Bid with delineated planned steps to qualify technological process to achieve these bends?

2. Achievable tolerances of coil builds

Presumed PF1-3 coils tolerances:

- Inner diameter $-0 + 0.1$ mm
- Outer diameter $-0 + 1$ mm
- Height $-0 + 1$ mm
- Top and bottom surface flatness 0.1 mm
 - Strict surface flatness tolerance is essential for us.

Please take note that we will require the manufacturer to keep some minimum thickness of turn-to-turn and ground insulation, therefore it will not be possible to arbitrarily reduce the thickness to correct for excessive insulation build-up.

Also, we will require the manufacturer to keep prescribed volumetric insulation fiberglass ratio (not set yet, but presumed 35 %).

Are these tolerances/requirements achievable? If not, what is reasonably achievable?

3. Insulation properties

Requirement	Value
volumetric fiberglass ratio	$40 \pm 5 \%$
turn-to-turn insulation nominal thickness	$2.0 \pm 0.2 \text{ mm}$
Ground insulation nominal thickness	$2.5 \pm 0.25 \text{ mm}$
Resin rich area (any direction)	max. 0.5 mm
void gap (any direction)	max. 25 μm
void ratio	max. 2.5 %
Polyimide tape width	80 % of GF tape

Glass Fiber Tape:

- E-glass
- plain/twill weave (satin probably to be avoided)
- ground insulation tape width 50+ mm

Recommended resin:

- Araldite GY 282

Recommended polyimide tape:

- DuPont Kapton FPC, 25 μm

Coil fillers:

- HPL material, recommended G-11CR

Are you able to fulfill these requirements?

4. Additional insulation wrap

- On top of the ground insulation, PF1-3 coils will have added **“insulation wraps”** evenly distributed at 8 toroidal angles.
- Each wrap **width is 50 mm** and **height is 9 mm**. On a single horizontal coil surface, these wraps will follow an **isosceles trapezoid shape** with base **angle 30°**.

These additional wraps will serve only mechanical purpose of toroidal coil fixation and help keep a centred coil position after thermal/force-induced expansion.

Do you see any trouble in manufacture of these additional wraps?
 Would it be better to VPI the base coil first and add the wraps later (using prepreg system) or vice versa? Trapezoidal wrap shape has quite a sharp angle, would it be a problem to manufacture such a shape and how would you propose to do it?

