

# CHALLENGER OF RECORD & DEFENDER

## AMERICA'S CUP 36

### Interpretation 084

of

### AC75 Class Rule Version 1.27 issued 15<sup>th</sup> January 2021

#### Rule References:

- 21.2 No **control system** or part thereof shall be capable of using feedback from the **yacht state** to control a **control surface**, except:
- (a) motion of a **control function** may be restricted where permitted by Rule 21.3;
  - (b) one or more **force input devices** may be connected **mechanically** and/or through an **HCC** to a single **control surface**; forces acting on that **control surface** can only be transmitted to those **force input devices**;
  - (c) one or more **force input devices** may be connected **mechanically** and/or through an **HCC** to common mechanical drive trains or common pressure supply lines that provide power to multiple **control surfaces**; forces acting on those **control surfaces** can be transmitted through those mechanical drive trains or pressure supply lines to those **force input devices**;
  - (d) as permitted within an **HCC** by Rules 22.5 (d) and 22.5 (e);
  - (e) as permitted within an **ECC** by Rule 24; and
  - (f) a **control surface** can move passively as the result of **external forces** acting on that **control surface**, providing the above Rules are respected.
- 21.3 A **control system** may restrict a **control function** as follows:
- (a) fixed stops, or stops engaged and disengaged **mechanically**, may limit the travel of a **control function**;
  - (b) locks that engage **mechanically** at (or very nearly at) either end of the extent of motion of a **control function** may be disengaged by an **ECC** and/or **HCC**, providing those extents of motion are not adjustable; and
  - (c) locks that limit the direction of motion of a **control function** at discrete points, e.g. ratchets, may engage **mechanically**.
- However, stops and locks permitted herein shall not be combined to provide greater control of a **control function**, and shall not be used in mechanisms such as, but not limited to, escapements, to achieve the effect of indexed control or position control.
- 22.7 A **hydraulic actuator** within an **HCC** may only be **mechanically** connected to one **control surface**.

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- 22.9 Hydraulic fluid may only be discharged from an **actuator chamber** (via tubing and permitted valves) to:
- (a) a **low-pressure circuit**;
  - (b) another **actuator chamber** of the same **hydraulic actuator**; or
  - (c) an **actuator chamber** of a different **hydraulic actuator**, where both **hydraulic actuators** are connected to the same **control surface**.

An **HCC** must not be capable of discharging hydraulic fluid from an **actuator chamber** to another **actuator chamber** connected to a different **control surface**, or to a high-pressure accumulator permitted by Rule 22.13 (a).

- 22.13 Energy may only be stored within **HCCs**:
- (a) by one supplied high-pressure accumulator per **yacht** with a maximum capacity (gas plus hydraulic fluid) of 2.0 litres;
  - (b) by accumulators permitted by Rule 22.8 (b);
  - (c) by gas in reservoirs in **low-pressure circuits**;
  - (d) by gas in **hydraulic actuators** with a gas spring return, providing the expansion of the gas volume cannot do work on a **control surface**. Such gas volumes may be physically separate from the **hydraulic actuators** they operate on, but may only be shared between **hydraulic actuators** that act on a common **control function**; and
  - (e) as elastic energy resulting from the compression of hydraulic fluid and the expansion of hoses in **high-pressure circuits**, providing that when all such circuits are pressurised to maximum pressure, no more than 350 ml of hydraulic fluid is discharged from drain ports when those ports are opened to atmosphere.

### 35.82 Mechanically

Only through contact of components, without the use of hydraulic, pneumatic, magnetic or electrical components.

### Questions:

Questions 1 – 3 concern the use of the phrase “may only be” in Rule 22.

1. Rule 22.9 states “Hydraulic fluid may only be discharged from an actuator chamber to a low pressure circuit, another actuator chamber of the same hydraulic actuator, or an actuator chamber of a different hydraulic actuator, where both...”.
  - a. Does Rule 22.9 prohibit hydraulic fluid from being *stored* in an actuator chamber?
  - b. Does Rule 22.9 prohibit hydraulic fluid from being *pumped or otherwise driven* into an actuator chamber (e.g. by a hydraulic pump)?
  - c. Does Rule 22.9 prohibit hydraulic fluid from being discharged from an actuator chamber except where permitted by 22.9(a)-(c)?
2. Rule 22.13 states “Energy may only be stored within HCCs by (a) one supplied high-pressure accumulator...”.
  - a. Does Rule 22.13 prohibit energy from being *released* by HCCs?
  - b. Does Rule 22.13 prohibit energy from being stored by components outside HCCs?
  - c. Does Rule 22.13 prohibit energy from being stored within HCCs, except where permitted by 22.13(a)-(e)?

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3. Rule 22.7 states “A hydraulic actuator within an HCC may only be **mechanically** connected to one control surface”.
  - a. Does Rule 22.7 prohibit a connection between a hydraulic actuator and any other component, except for a mechanical connection to one control surface?
  - b. Does Rule 22.7 prohibit more than one control surface to be **mechanically** connected to a hydraulic actuator within an HCC?
4. Rule 21.2 refers to components that are connected **mechanically**. Rule 21.3(b) allows locks that engage **mechanically** to be disengaged by an **ECC** and/or an **HCC**, thereby making a distinction between mechanical engagement and non-mechanical disengagement. If a pair of components are **mechanically** connected, does this refer to the act of making or unmaking the connection, or the state when the components are connected?

5. Figure 1 depicts a hydraulic actuator (part of HCC – A) that is connected to a mechanical linkage with two arms. One arm of the linkage is connected to Control Surface 1, the other arm is connected to a master-slave hydraulic circuit (HCC – B), which is in turn connected to Control Surface 2.

As the actuator in HCC-A extends and retracts, the mechanical linkage is pushed/pulled, moving Control Surface 1. At the same time, the master-slave circuit of HCC-B is driven by the mechanical linkage, and the slave cylinder moves Control Surface 2.

Is the hydraulic actuator in HCC – A only **mechanically** connected to control surface 1? If not, why?

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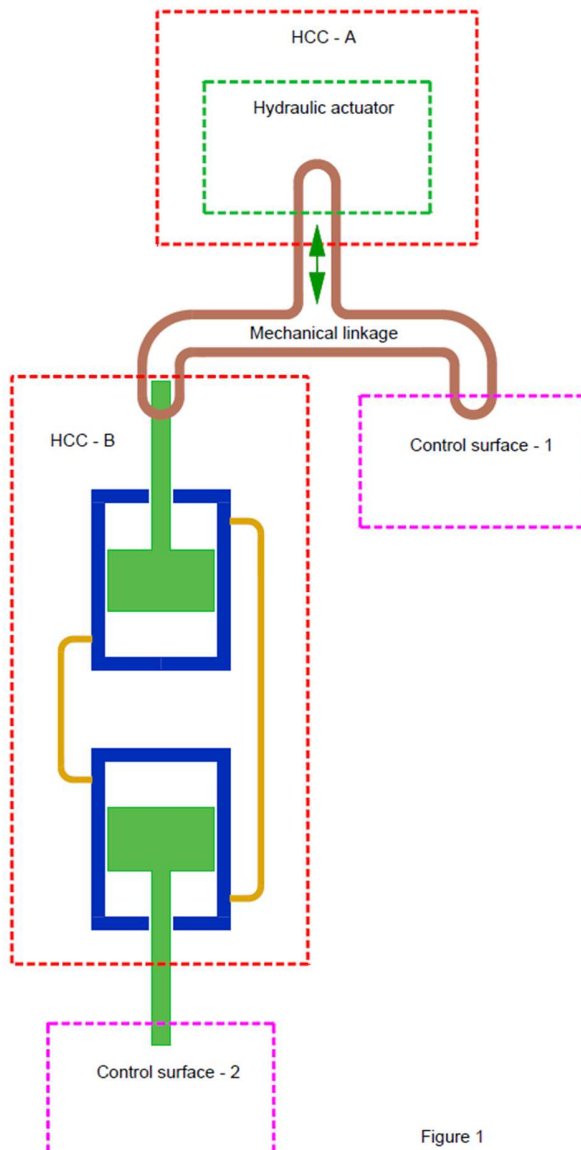


Figure 1

6. Figure 2 depicts a hydraulic actuator, a component of HCC – A, that is connected to a piston in HCC – B via a mechanical linkage. HCC – B comprises a piston and cylinder, a pair of pressure relief valves, a pair of check valves, and a low pressure tank.

The cylinder of HCC B is connected to a control surface via mechanical linkage. Under normal external forces, there is no flow in HCC B; when sufficient (abnormally large) external force is applied to the control surface, a pressure relief valve opens, and the control surface is free to move.

- Does HCC – B contain a hydraulic actuator?
- Is HCC – A **mechanically** connected to the control surface?
- Does the answer to (a) or (b) change if the two pressure relief valves are replaced by non-return valves, such that oil was prevented from leaving or entering either chamber of the cylinder in HCC – B?

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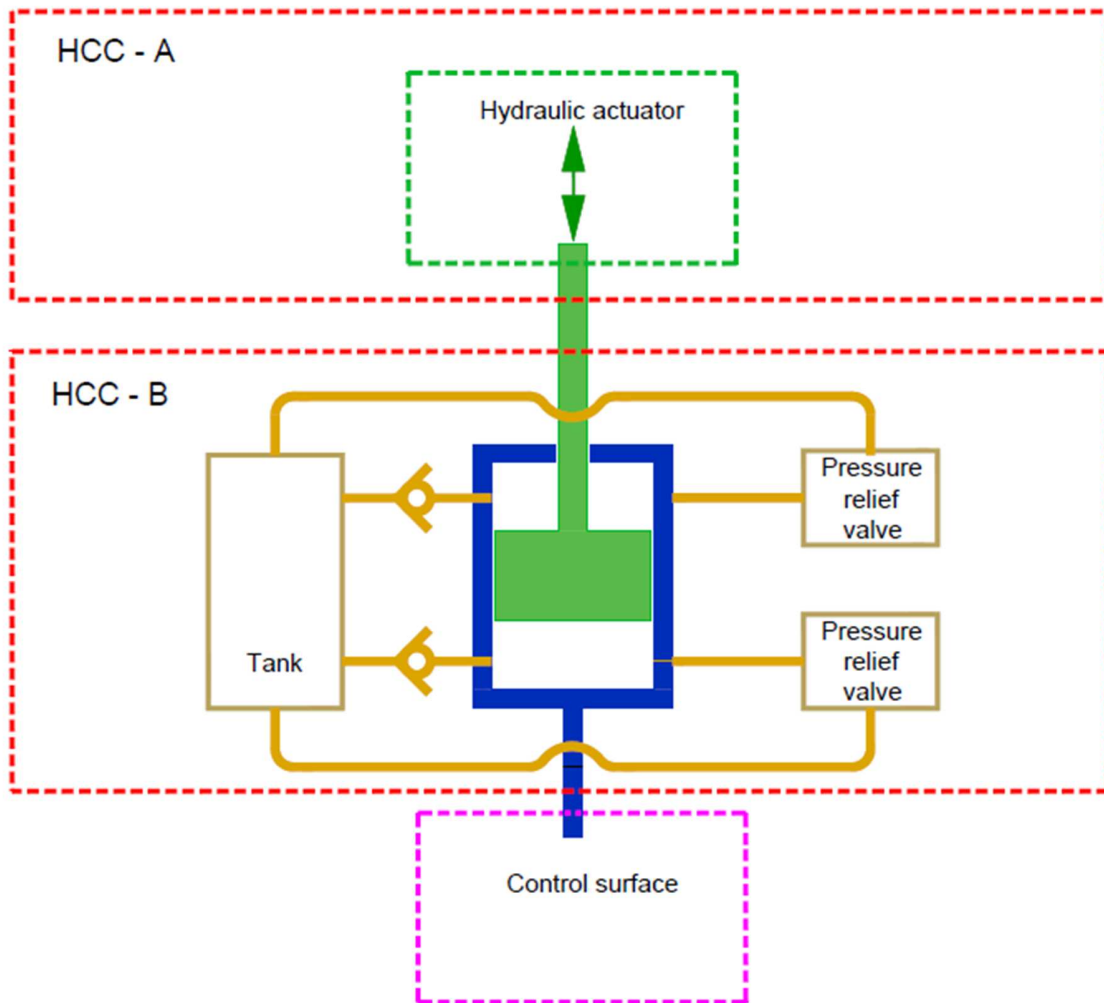


Figure 2

7. Figure 3 depicts a pneumatically actuated lock between a hydraulic actuator and a control surface, such that pneumatic pressure is used to move the jaws together and/or apart. Is the hydraulic actuator **mechanically** connected to the control surface?

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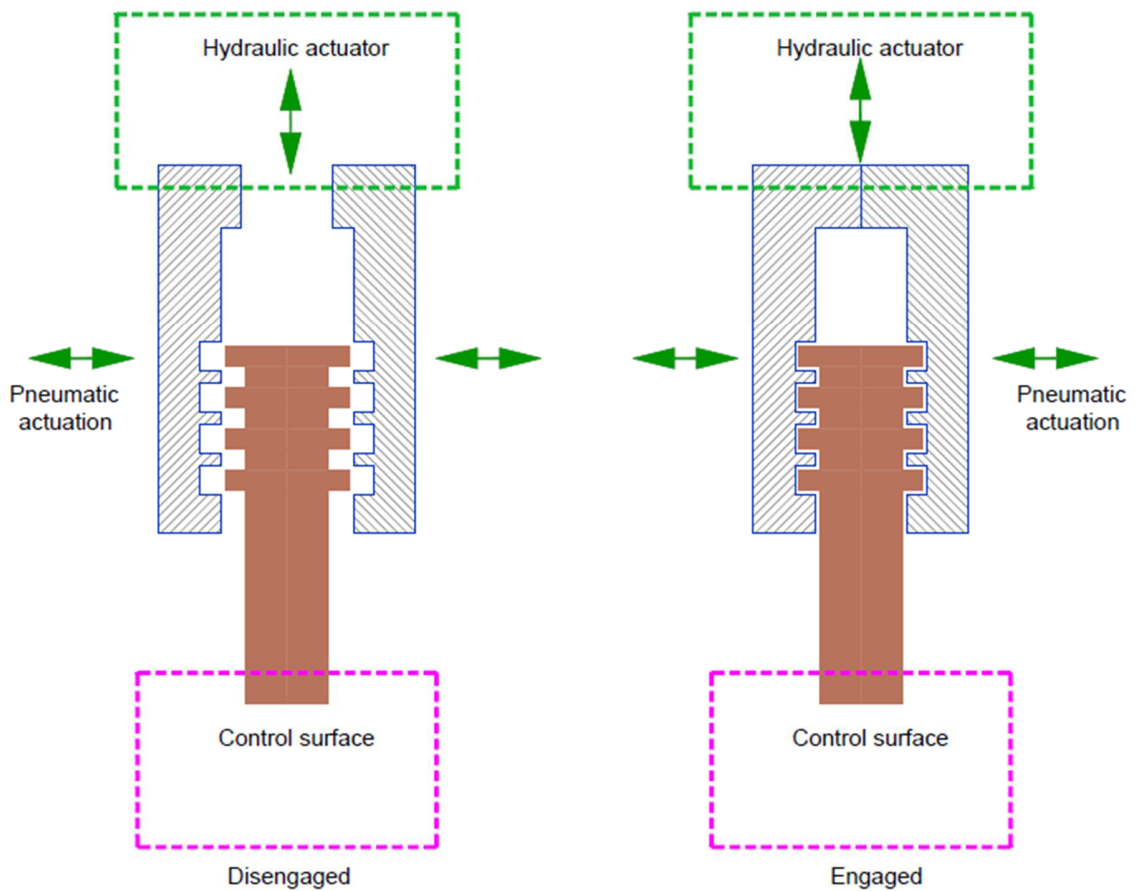


Figure 3

### Interpretation:

- A. The **Rules Committee** interprets Rule 22.7 to mean: “the limit on the number of **control surfaces** that a **hydraulic actuator** within an **HCC** may be **mechanically** connected to is one.”
- B. Note the definition of **Hydraulic Actuator**:

#### 35.55 **Hydraulic actuator**:

*A hydraulic ram, hydraulic motor or functionally equivalent device that converts hydraulic pressure and flow into force and translation, and/or torque and rotation.*

The **Rules Committee** considers that zero is a valid rate of flow and similarly zero is a valid translation rate. Consider a jack as an example of a **hydraulic actuator**. In one method of use, fluid is pumped under pressure to raise the jack. Once raised, and pumping stops, the fluid flow is zero, translation is zero, and whatever pressure is necessary to support the load exists within the actuator chamber. When the jack is stopped the jack remains a **hydraulic actuator**. The operator of the jack has set the fluid flow to zero in order achieve zero translation.

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### Answers:

1.
  - a) No.
  - b) No.
  - c) Yes.
2.
  - a) No
  - b) No
  - c) Yes
3. See Interpretation A.
  - a) No, Rule 22.7 only restricts the number of **control surfaces** that can be **mechanically** connected to a **hydraulic actuator**.
  - b) Yes.
4. In Rule 21.2, **mechanically** connected refers to the state of being connected. In Rule 21.3 “Engage” or “disengage” **mechanically** refers to the act of becoming connected or disconnected.
5. Figure I shows a prohibited configuration. HCC-B in Figure I breaks Rule 22.9. The **Rules Committee** does not answer with respect to prohibited configurations.
6.
  - a) Yes. HCC-B contains a **hydraulic actuator**. See Interpretation B.
  - b) No.
  - c) No. Furthermore, HCC-B is prohibited by Rule 22.3.
7. When the lock is in the state of the jaws being together, then the **hydraulic actuator** is in the state of being **mechanically** connected to the **control surface**. The pneumatic actuation must comply with Rule 21.2, Rule 21.3 and 21.4.

END