AATRIZINVENTOR SOLUTION FOR INNOVATION BASED ON NATURE'S L.I.
Working Document to Build a Specific Solution.

INNOVATION CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

APLICATION OF NATURE'S LANGUAGE OF INNOVATION / Nature's L.I.
Web site: www.aatrizinventor.com
Reference book: The Nature's Language of Innovation, José Roberto Espinoza, Amazon, Kindle.

FACTORS OF INNOVATION:
ACTION VERB: Improve
FUNCTION AFFECTED: Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !
PHYSICAL VARIABLE OR CHARACTERISTIC: Ability to connect different areas
S1 OBJECT: CIRCULAR COOLING DUCT Type: Stationary
S2 OBJECT: SQUARE CO2 FILTER Type: Stationary

INNOVATION CHALLENGE:
CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !
DESIRED GOAL: More Ability to connect different areas
EVALUATED OBJECT: CIRCULAR COOLING DUCT
NEED TO SATISFY > 33. Ease of operation

SELECTED INNOVATION PARAMETERS TO EVALUATE:
A. UNDESIRABLE EFFECTS CAUSES OF DISSATISFACTION (UDEs)
There are More difficulty to Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem ! because:
CIRCULAR COOLING DUCT Has Less Own area or two-dimensional scope interacting with S2
CIRCULAR COOLING DUCT Has Less Appropriate shape, composition, or configuration interacting with S2
CIRCULAR COOLING DUCT Has More Harmful factors affecting it by interacting with S2
CIRCULAR COOLING DUCT Has More Complexity of equipment or action interacting with S2
There are undesirable effects that cause dissatisfaction because:
There is Less Ability to connect different areas
B. DESIRED EFFECT FOR NEED TO SATISFY
There is More ease to Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem ! because:
CIRCULAR COOLING DUCT Has More Desired ease of operation to interact with S2
There is desirable effect for need to satisfy because:
There is More Ability to connect different areas

Table I. RELATIONSHIP WITH UNIVERSAL TRIZ INNOVATION PARAMETERS (maximum of 7 undesirable effects)
CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

This table presents the selected innovation parameters to evaluate the challenge that must be resolved for the interaction between an Object S1 and an Object S2, and no others. The choice of undesirable effects must be based on a thorough review of the current situation, identifying them based on the objective evidence present within the predefined space and time of evaluation. Fulfilling this requirement is crucial: If you do not connect the dots of the current situation properly, the algorithm will deliver a disconnected solution.
The selection of the need to satisfy should reflect the best estimation of the innovation-evolution state of the object S1 being evaluated.
Recognizing the criticality of this selection process, the Aatrizinventor algorithm provides flexibility to change parameters and conducts a sensitivity analysis in order to offer alternative solutions. These alternatives are based on different combinations of the entered parameters, also including a different need to satisfy from the one originally posed.

Parameters to evaluate(s)	**It is understood as CIRCULAR COOLING DUCT has:**
Parámeters of undesirable effects (UDE):	**Undesirable effects causes of dissatisfaction:**
(-) 6. Area of stationary object	Less Own area or two-dimensional scope interacting with S2
(-) 12. Shape / composition / configuration	Less Appropriate shape, composition, or configuration interacting with S2
(+) 30. Object-affected harmful factors	More Harmful factors affecting it by interacting with S2
(+) 36. Complexity of Device/ Action	More Complexity of equipment or action interacting with S2
Desirable parameter (DE):	**Desirable Effect for Need to satisfy:**
(+) 33. Ease of operation	More Desired ease of operation to interact with S2
TRIZ undesirables parameters for sensitivity analysis	**It is understood as CIRCULAR COOLING DUCT has:**
(+) 31. Object-generated harmful factors	More Harmful factors affecting S2 by mutual interaction
n/a	
n/a	
n/a	
n/a	

EVALUTION RESULTS TABLES

TABLE II. SPECIFIC CONTRADICTION MATRIX FOR UNDESIRABLE EFFECTS AND NEED TO SATISFY. FOR EVALUATED OBJECT: CIRCULAR COOLING DUCT AND NEED TO BE SATISFIED > 33. Ease of operation

CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

(*) Preferred parameters: Improve 12. Shape / composition / configuration & Attenuate or preserve 30. Object-affected harmful factors.
Contradictions/ E.C: Essential, Comp.:Complementary, Top 5: Up to the major fifth, noted if outside the preferred parameters.
Parameters in the first row are the same as those in the first column.

Parameter to attenuate or preserve => Parameter to improve	Var.	(-) Par.6	(-) Par.12	**(+) Par.30 PREF.**	(+) Par.36	(+) Par.33	Sum wt
(-) 6. Area of stationary object	wt		-	**wt.5 Compl.**	wt.11	wt.15	36%
	IP(s)	0,0,0,0	0,0,0,0	27,2,39,35	1,18,36,0	16,4,0,0	
(-) 12. Shape / composition / configuration PREF.	wt	-		**wt.1 E.C.**	**wt.2 Compl.**	**wt.4 Compl.**	100%
	IP(s)	0,0,0,0	0,0,0,0	22,1,2,35	16,29,1,28	32,15,26,0	
(+) 30. Object-affected harmful factors	wt	wt.6	wt.14		wt.8	wt.13	52%
	IP(s)	27,2,39,35	22,1,3,35	0,0,0,0	22,19,29,40	2,25,28,39	
(+) 36. Complexity of Device/ Action	wt	wt.17	wt.9	**wt.7 Compl.**		wt.16	40%
	IP(s)	6,36,0,0	29,13,28,15	22,19,29,40	0,0,0,0	27,9,26,24	
(+) 33. Ease of operation	wt	**wt.3 Top 5**	wt.9	**wt.12 Compl.**	wt.18		60%
	IP(s)	18,16,15,39	15,34,29,28	2,25,28,39	32,26,12,17	0,0,0,0	
Sum wt		51%	38%	85%	73%	41%	

This table shows the essential contradiction (E.C.) that determines the solution strategy. Additionally, preferred parameters are established where complementary contradictions (Compl.) are found, allowing the definition of the Base Solution shown in Table III.
As a complement to the Base Solution, Table II also provides the following information that could be

relevant to obtain an optimal solution:
a) The algorithm identifies the top 5 contradictions from the entire Table II and highlights those that are outside the preferred parameters for further review.
b) There are inventive principles present in Table II that are not part of the Recommended Solution proposed in Table V. In the latter, the top three most relevant ones are highlighted, and the contradictions they involve are presented to evaluate whether they contribute significant aspects to the desired solution. For further details, Table VIII provides a prioritization of the inventive principles from Table II, and those not included in the Recommended Solution in Table V are marked with ***.

TABLE III. BASE SOLUTION FOR THE EVALUATED OBJECT: CIRCULAR COOLING DUCT
NEED TO SATISFY > 33. Ease of operation
CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

Table II Selection: Essential Contradiction wt.1 y Complementary contradictions with preferred parameters (*) wt.2/wt.4/wt.5/wt.7

Parameter to improve	Parameter to attenuate or preserve	Contradict.	Wt.n	IP. Ord.1	IP Ord 2	IP Ord 3	IP Ord 4
(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	Essential	wt.1	**22 Es.**	**1 Es.**	**2 Es.**	**35 Es.**
(-) 12. Shape / composition / configuration	(+) 36. Complexity of Device/ Action	Compl. 1	wt.2	16	29	**1 Es.**	28
(-) 12. Shape / composition / configuration	(+) 33. Ease of operation	Compl. 2	wt.4	32	15	26	0
(-) 6. Area of stationary object	(+) 30. Object-affected harmful factors	Compl. 3	wt.5	27	**2 Es.**	39	**35 Es.**
(+) 36. Complexity of Device/ Action	(+) 30. Object-affected harmful factors	Compl. 4	wt.7	**22 Es.**	19	29	40

Inventive Principles (IP) selected for the Base Solution
IP.22. Convert harm in benefit - strategic type
IP.1. Segmenting/ Integrating - strategic type
IP.2. Taking out/ Adding - strategic type
IP.35. Transformation / Parameter Changes - strategic type
IP.16. Partial or Excessive Actions - **operative type**
IP.29. Controllable Soft Variables - tactical type
IP.28. Mechanics Substitution - strategic type
IP.32. Perception/ Appearance/ Color Changes - strategic type

IP.15. Dynamics - strategic type
IP.26. Copying/ Replicating - strategic type
IP.27. Cheap Short-Living Objects - strategic type
IP.39. Inert Atmosphere / Environment - **operative type**
IP.19. Time-Varying Action/ Periodic or Pulsating - strategic type
IP.40. Composite Materials/ Conditions - **operative type**

Table III shows the essential contradiction, the one with the highest weight, plus the following 4 complementary contradictions in weight, which are located in the row and column of the preferred parameters selected in Table II. These contradictions are considered relevant for the solution and are described as the Base Solution in Table IX.
Keep in mind that all inventive principles selected for a solution must be evaluated according to the specific context of the contradictions in which they participate.
Inventive principles marked with 'Es.' correspond to inventive principles that belong to the essential contradiction.

TABLE IV. CONTRADICTION MATRIX COVERAGE FOR SOLUTION AMONG NEEDS TO SATISFY FOR EVALUATED OBJECT: CIRCULAR COOLING DUCT, NEED TO BE SATISFY: 33. Ease of operation

Coverage is defined as the extent to which the inventive principles from Table II encompass the inventive principles from Table IV. If weighted coverage is higher, it has been observed that the obtained solution is more likely to have the lowest cost and the maximum benefit-to-cost ratio.

Parameter to improve	Parameter to preserve	IP. Ord.1	IP Ord 2	IP Ord 3	IP Ord 4
33. Ease of operation	32. Ease of achieving desired outcome	2	**5 nT2**	12	0
33. Ease of operation	27. Reliability	17	27	**8 nT2**	40
33. Ease of operation	13. Stability	32	35	**30 nT2**	0
33. Ease of operation	33. Ease of operation	0	0	0	0
33. Ease of operation	34. Ease of change, repair or maintain	12	26	1	32
33. Ease of operation	20. Use of energy by stationary object	0	0	0	0
33. Ease of operation	39. Productivity	15	1	28	0
33. Ease of operation	38. Extent of automation/ autonomy	1	34 nT3	12	3 nT3
33. Ease of operation	35. Adaptability or versatility	15	34 nT3	1	16

33. Ease of operation	16. Duration of action by stationary object	1	16	25 nT3	0

Inventive Principles (IP) selected for the Solution of relevant Contradictions between Needs to Satisfy
IP.2. Taking out/ Adding - strategic tpe
IP.5. Merging/ Separating - **operative type**
IP.12. Equipotentiality - tactical type
IP.17. Another Dimension or Field - tactical type
IP.27. Cheap Short-Living Objects - strategic tpe
IP.8. Anti-Weight/ Compensation - tactical type
IP.40. Composite Materials/ Conditions - **operative type**
IP.32. Perception/ Appearance/ Color Changes - strategic tpe
IP.35. Transformation / Parameter Changes - strategic tpe
IP.30. Simple Shapes/ Ways to Interact - tactical type

94.82 % weighted coverage of the inventive principles (IP) included in Table IV. of Contradictions between Needs to Satisfy (NS), in relation to the IP included in Table II Specific Contradiction Matrix.
The inventive principles labeled with nT2 are not found in Table II. Due to this condition, the first three contradictions in Table IV containing principles marked with nT2 are described as a Solution among Needs to Satisfy in Table IX. This solution, combined with the previously mentioned Base Solution, forms the Recommended Solution by the Aatrizinventor Algorithm, shown in Table V.
From practical experience, if Table IV contains more than 3 contradictions with inventive principles not included in Table II, then it is likely to be more challenging to construct a specific solution. In that case, it is recommended to look for an alternative combination of parameters in Table VI of sensitivity analysis. It is also an option to select another need to satisfy, which is shown in Table VII Essential Contradictions of Needs to Satisfy (NS) for the same undesirable effects already evaluated for CIRCULAR COOLING DUCT.
To evaluate the recommended inventive principles here and the corresponding contradictions in which they participate, it is necessary for the Base Solution to guide an initial context for the solution, as the contradictions between Needs to Satisfy do not identify which variable of the evaluated object S1 should be operated.
Inventive principles labeled with nT3 are included in Table II, but do not participate in the Recommended Solution shown in Table V. The Innovation Team must review the contradictions where they participate, to determine if there were other specific aspects that could be significant for the solution.
Unmarked inventive principles are included in Table II Specific Contradiction Matrix and in Table V Recommended Solution.

TABLE V. RECOMMENDED SOLUTION FOR INNOVATION CHALLENGE FOR EVALUATED OBJECT CIRCULAR COOLING DUCT
CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !
Evaluated need to satisfy in this report: **33. Ease of operation**
UDEs: (-) 6. Area of stationary object// (-) 12. Shape / composition / configuration// (+) 30. Object-affected harmful factors// (+) 36. Complexity of Device/ Action

Parameter to improve	Parameter to attenuate or preserve	Contradict.	Wt.n	IP. Ord.1	IP Ord 2	IP Ord 3	IP Ord 4
(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	Essential	wt.1	**22 Es.**	**1 Es.**	**2 Es.**	**35 Es.**
(-) 12. Shape / composition / configuration	(+) 36. Complexity of Device/ Action	Compl. 1	wt.2	16	29	**1 Es.**	28
(-) 12. Shape / composition / configuration	(+) 33. Ease of operation	Compl. 2	wt.4	32	15	26	0
(-) 6. Area of stationary object	(+) 30. Object-affected harmful factors	Compl. 3	wt.5	27	**2 Es.**	39	**35 Es.**
(+) 36. Complexity of Device/ Action	(+) 30. Object-affected harmful factors	Compl. 4	wt.7	**22 Es.**	19	29	40
33. Ease of operation	32. Ease of achieving desired outcome	NS.1	wns.1	**2 Es.**	5	12	0
33. Ease of operation	27. Reliability	NS.2	wns.2	17	27	8	40
33. Ease of operation	13. Stability	NS.3	wns.3	32	**35 Es.**	30	0

Relevant inventive principles from Table II not included in Recommended Solution

Before deciding on the solution, make sure you have previously reviewed the contradictions with relevant Inventive Principles from Table II, not included in the Recommended Solution. The 3 most relevant are shown below.

IP.18. Mechanical Vibrations/ Energy Variations (Pos.9) ***	IP. Tac.	[Par.33][Par.6][IP(s) : 18,16,15,39] - [Par.6][Par.36][IP(s) : 1,18,36,0] -
IP.6. Universality (Pos.10) ***	IP. Tac.	[Par.36][Par.6][IP(s) : 6,36,0,0] -
IP.25. Self-service (Pos.11) ***	**IP. Oper.**	[Par.33][Par.30][IP(s) : 2,25,28,39] - [Par.30][Par.33][IP(s) : 2,25,28,39] -

Inventive Principles (IP) selected for Recommended Solution:

To develop a Specific Solution based on the contradictions provided in Table V, where S1: CIRCULAR COOLING DUCT interacts with S2: SQUARE CO2 FILTER, the Innovation Team must analyze the recommended innovation concepts for each selected inventive principle listed below. At least one concept from each principle that is applicable to the challenge under evaluation should be chosen.

Once the concepts are selected per inventive principle, it is essential to conduct an 'integrated reading' of the contradictions indicated in Table V. If this 'integrated reading' can demonstrate a coherent logical thread for each selected contradiction and as a whole, then it can be considered that there is a potential innovation solution.
To complete the definition of the specific solution, it is necessary to review the relevant inventive principles from Table II that were not included in the Recommended Solution in Table V, which are presented above.
For more details on the selected contradictions, you can review the complete descriptions of the inventive principles by contradiction, as shown in Table IX.
In the Starting Manual, Fundamentals of Aatrizinventor, Point 11, an example is provided for developing the Specific Solution based on the Recommended Solution by the Aatrizinventor algorithm, based on the 'Language of Nature Innovation.' The identification of a specific solution is a systematic and iterative process involving multiple concepts, aiming to determine a comprehensive solution with minimal implementation costs and maximum benefit-to-cost ratio.
It's important noting that an asterisk (*) has been added to the name of the object under evaluation to remind that the descriptions of the inventive principles may consider that CIRCULAR COOLING DUCT can be in its current physical and functional state, or in a modified state, or even in a new state, as needed to achieve the desired objective. Please, make the most of your relational thinking skills.

Summary description of the Inventive Principles included in the Recommended Solution shown above, applicable to the challenge under evaluation for the defined space and time:

N°1 Improve: (-) 12. Shape / composition / configuration and Attenuate or Preserve: (+) 30. Object-affected harmful factors

IP.22. Convert harm in benefit - strategic type (1)

a. Use harmful factors, or external effects related to harmful factors, for OBJECT S1 (particularly, effects of the environment or surroundings) to achieve a positive effect with CIRCULAR COOLING DUCT*.
b. Eliminate a harmful primary action by adding another action to CIRCULAR COOLING DUCT*, which counteracts the harmful action to solve the problem.
c. Amplify a harmful factor or a part of CIRCULAR COOLING DUCT*, to such a degree that it is no longer harmful.

IP.1. Segmenting/ Integrating - strategic type (2)

a. Divide CIRCULAR COOLING DUCT* into existing and/or new parts, shapes, phases, states, or conditions.
b. Integrate different existing or new parts, forms, phases, states or conditions of CIRCULAR COOLING DUCT* in a single entity.
c. Make CIRCULAR COOLING DUCT* easy to disassemble or assemble.
d. Increase or reduce the degree of fragmentation or segmentation of CIRCULAR COOLING DUCT*.

IP.2. Taking out/ Adding - strategic type (3)

a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*. **b.** Add new parts or properties to CIRCULAR COOLING DUCT*.

IP.35. Transformation / Parameter Changes - strategic type (4)

a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a

gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.

N°2 Improve: (-) 12. Shape / composition / configuration and Attenuate or Preserve: (+) 36. Complexity of Device/ Action
IP.16. Partial or Excessive Actions - operative type (5)
a. If the objective of CIRCULAR COOLING DUCT* in its interaction with SQUARE CO2 FILTER is difficult to fully achieve using a given solution, then use 'a little less' or 'a little more' of the same solution.
IP.29. Controllable Soft Variables - tactical type (6)
a. Use external, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) to interact with CIRCULAR COOLING DUCT* facilitating goal fulfillment of the function performed with Object S2.
b. Make easier CIRCULAR COOLING DUCT* interact with Object S2 using internal, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) available in S1 and / or S2, facilitating goal fulfillment.
IP.1. Segmenting/ Integrating - strategic type (7)
a. Divide CIRCULAR COOLING DUCT* into existing and/or new parts, shapes, phases, states, or conditions.
b. Integrate different existing or new parts, forms, phases, states or conditions of CIRCULAR COOLING DUCT* in a single entity.
c. Make CIRCULAR COOLING DUCT* easy to disassemble or assemble.
d. Increase or reduce the degree of fragmentation or segmentation of CIRCULAR COOLING DUCT*.
IP.28. Mechanics Substitution - strategic type (8)
a. Replace a direct or manual action in, or for, CIRCULAR COOLING DUCT*, with a mechanical action or a tool.
b. Replace a mechanical means in, or for, CIRCULAR COOLING DUCT*, with sensory (optical, acoustic, vibration, taste, smell, feelings or other sensory fields) means.
c. Use mechanical, pneumatic, hydraulic, electric, magnetic, and electromagnetic, chemical, biological, psychological or other fields gto improve action of CIRCULAR COOLING DUCT*.
d. Change from static fields in, or for, CIRCULAR COOLING DUCT* to moving fields, from unstructured fields to those with structure, or vice versa.
e. Use fields in conjunction with field-activated parts, components, or particles (e.g., magnetic field and ferromagnetic particles) in, or for, CIRCULAR COOLING DUCT*.

N°3 Improve: (-) 12. Shape / composition / configuration and Attenuate or Preserve: (+) 33. Ease of operation
IP.32. Perception/ Appearance/ Color Changes - strategic type (9)
a. Change how is perceived, the appearance or shape of CIRCULAR COOLING DUCT* in relation to the object S2 with which it interacts.
b. Change the color, or appearance, of CIRCULAR COOLING DUCT* or its external environment.
c. Change the transparency of CIRCULAR COOLING DUCT* or its external environment.

IP.15. Dynamics - strategic type (10)
a. Allow (or design) the characteristics of CIRCULAR COOLING DUCT*, external environment, or process to change to an optimal, or to find an optimal, operating condition.
b. Divide CIRCULAR COOLING DUCT* into parts that are capable of relative movement between each other.
c. If CIRCULAR COOLING DUCT* (or process) is rigid or inflexible, make it flexible or adaptive.
d. To enhance the dynamics of CIRCULAR COOLING DUCT* or the process, use feature(s) or object(s) available in the nearby environment.
IP.26. Copying/ Replicating - strategic type (11)
a. Instead of using CIRCULAR COOLING DUCT*, or any of its unavailable, expensive, fragile parts or properties, use simpler and inexpensive copies or replicates to perform the desired function and, if possible, do so with improved characteristics and properties, while disregarding the harmful, undesirable, or unnecessary ones.
b. Imitate CIRCULAR COOLING DUCT*, or any of its parts or properties, leveraging the relevant available environment.
c. If simple copies, or replicates are already being used, apply copies, or replicates of a higher level or technical

N°4 Improve: (-) 6. Area of stationary object and Attenuate or Preserve: (+) 30. Object-affected harmful factors
IP.27. Cheap Short-Living Objects - strategic type (12)
a. Replace or divide (either fully or partially) CIRCULAR COOLING DUCT* or its action with multiple inexpensive or short-living objects, actions, or sub-parts, which compress or simplify its characteristics and properties, and/or are limited but sufficient to achieve the desired objective.
b. Compress certain qualities of CIRCULAR COOLING DUCT* (e.g., the degree of participation, complexity, or lifetime), with no loss of functionality, to achieve the desired objective.
IP.2. Taking out/ Adding - strategic type (13)
a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*. **b.** Add new parts or properties to CIRCULAR COOLING DUCT*.
IP.39. Inert Atmosphere / Environment - operative type (14)
a. Replace a currently harmful or undesirable environment for CIRCULAR COOLING DUCT* with an inert one, either fully or partially.
b. Add neutral parts, or inert additives to OBJECT S1 or its environment.
c. Leave the harmful environment for OBJECT S1 towards another environment or dimension.
IP.35. Transformation / Parameter Changes - strategic type (15)
a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.

N°5 Improve: (+) 36. Complexity of Device/ Action and Attenuate or Preserve: (+) 30. Object-affected harmful factors

IP.22. Convert harm in benefit - strategic type (16)
a. Use harmful factors, or external effects related to harmful factors, for OBJECT S1 (particularly, effects of the environment or surroundings) to achieve a positive effect with CIRCULAR COOLING DUCT*.
b. Eliminate a harmful primary action by adding another action to CIRCULAR COOLING DUCT*, which counteracts the harmful action to solve the problem.
c. Amplify a harmful factor or a part of CIRCULAR COOLING DUCT*, to such a degree that it is no longer harmful.
IP.19. Time-Varying Action/ Periodic or Pulsating - strategic type (17)
a. Instead of using continuous action in, or for, CIRCULAR COOLING DUCT*, use time-varying, periodic, or pulsating actions.
b. If the action of CIRCULAR COOLING DUCT* is already periodic, change the periodic magnitude or frequency.
c. Use pauses between impulses to perform a different action of CIRCULAR COOLING DUCT*.
d. If the current action of CIRCULAR COOLING DUCT* is time-varying, and if necessary, change to an action higher or lesser time-varying.
IP.29. Controllable Soft Variables - tactical type (18)
a. Use external, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) to interact with CIRCULAR COOLING DUCT* facilitating goal fulfillment of the function performed with Object S2.
b. Make easier CIRCULAR COOLING DUCT* interact with Object S2 using internal, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) available in S1 and / or S2, facilitating goal fulfillment.
IP.40. Composite Materials/ Conditions - operative type (19)
a. Change from a uniform material, property, state, or condition in, or for, CIRCULAR COOLING DUCT* , to a composite one, or vice versa.

N°6 Improve: 33. Ease of operation and Preserve: 32. Ease of achieving desired outcome
IP.2. Taking out/ Adding - strategic type (20)
a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*. **b.** Add new parts or properties to CIRCULAR COOLING DUCT*.
IP.5. Merging/ Separating - operative type (21)
a. Bring CIRCULAR COOLING DUCT* closer or merge with other objects with similar or identical operations or functions.
b. Bring CIRCULAR COOLING DUCT* closer or merge with other objects with similar operations or functions for them to act together at the same time.
c. Merge different shapes or actions into CIRCULAR COOLING DUCT*.
d. If there are objects fused to CIRCULAR COOLING DUCT, and if necessary, apply a separation action.
IP.12. Equipotentiality - tactical type (22)
a. In a potential field, limit position changes or energy variations of CIRCULAR COOLING DUCT*.
b. Change operating conditions to eliminate the need to change the position or energy quality of CIRCULAR COOLING DUCT* in a potential field.

N°7 Improve: 33. Ease of operation and Preserve: 27. Reliability

IP.17. Another Dimension or Field - tactical type (23)
a. Add or remove physical dimensions or fields of action of CIRCULAR COOLING DUCT*.
b. Move CIRCULAR COOLING DUCT* to a new dimension in space or performance field.
c. Use for CIRCULAR COOLING DUCT* multi-story arrangement of objects instead of a single-story arrangement.
d. Tilt or re-orient CIRCULAR COOLING DUCT*; lay it on its side.
e. Use another side of a given dimension or field of CIRCULAR COOLING DUCT*.
IP.27. Cheap Short-Living Objects - strategic type (24)
a. Replace or divide (either fully or partially) CIRCULAR COOLING DUCT* or its action with multiple inexpensive or short-living objects, actions, or sub-parts, which compress or simplify its characteristics and properties, and/or are limited but sufficient to achieve the desired objective.
b. Compress certain qualities of CIRCULAR COOLING DUCT* (e.g., the degree of participation, complexity, or lifetime), with no loss of functionality, to achieve the desired objective.
IP.8. Anti-Weight/ Compensation - tactical type (25)
a. To compensate for the heaviness/lightness or incidence of CIRCULAR COOLING DUCT*, merge it with other objects or independent own parts that provide an effect to improve the current situation.
b. To compensate for the heaviness/lightness or incidence of CIRCULAR COOLING DUCT*, make it interact with the environment.
IP.40. Composite Materials/ Conditions - operative type (26)
a. Change from a uniform material, property, state, or condition in, or for, CIRCULAR COOLING DUCT* , to a composite one, or vice versa.

N°8 Improve: 33. Ease of operation and Preserve: 13. Stability
IP.32. Perception/ Appearance/ Color Changes - strategic type (27)
a. Change how is perceived, the appearance or shape of CIRCULAR COOLING DUCT* in relation to the object S2 with which it interacts.
b. Change the color, or appearance, of CIRCULAR COOLING DUCT* or its external environment.
c. Change the transparency of CIRCULAR COOLING DUCT* or its external environment.
IP.35. Transformation / Parameter Changes - strategic type (28)
a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.
IP.30. Simple Shapes/ Ways to Interact - tactical type (29)
a. Use flexible rods and ropes, or similar one-dimensional functionality, or shells and thin films, or similar two-dimensional functionality, for CIRCULAR COOLING DUCT*, instead of complex three-dimensional structures, in type and number of components and shapes.
b. Separate/isolate CIRCULAR COOLING DUCT* from the external environment with simple shapes, using flexible rods and ropes, or similar one-dimensional, or shells and thin films, or similar two-dimensional.
c. Use in or for CIRCULAR COOLING DUCT* simple forms or ways of interacting with object S2, predominantly in one or two dimensions, with other dimensions reduced to a minimum. This is in order to reduce the number of resources and actions necessary to achieve the desired objective.

Relevant inventive principles from Table II not included in Recommended Solution

IP.18. Mechanical Vibrations/ Energy Variations (Pos.(9) - tactical type (30)

a. Move CIRCULAR COOLING DUCT* by cycles with energies that activate it.

b. Cause CIRCULAR COOLING DUCT* to oscillate or vibrate. Increase its frequency (even up to the ultrasonic). Use the resonant frequency of CIRCULAR COOLING DUCT*. If necessary, decrease frequency.

c. Use vibration-generating fields in, or for, CIRCULAR COOLING DUCT* instead of mechanical vibration generators. Combine sources of oscillations.

d. Apply alternation of CIRCULAR COOLING DUCT* or its parts or functions.

(Pos.() (31)

IP.25. Self-service (Pos.(11) - operative type (32)

a. Make CIRCULAR COOLING DUCT* serve itself by performing helpful auxiliary functions.

b. Use resources, energy or substances that are wasted or unused by CIRCULAR COOLING DUCT*. **c.** Incorporate resources and/or functions into CIRCULAR COOLING DUCT* for self-service during operation.

TABLE VI. RESULTS OF SENSITIVITY ANALYSIS FOR THE EVALUATED OBJECT CIRCULAR COOLING DUCT

CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

Coverage obtained for the current evaluation to compare with sensitivity analysis

Order	Par.1	Par.2	Par.3	Par.4	Par.5	Cob. NS (%)	Cob. EC (%)	Cob. GL (%)
1	6	12	30	36	33. Ease of operation	94.82	100	96.12

Table VI presents the 10 most favorable parameter combinations recommended by the Aatrizinventor algorithm. It is suggested to evaluate the 2 or 3 most relevant ones. Practice teaches that they often contain the best solution for the evaluated challenge.

(E) Combination of TRIZ innovation parameters evaluated in this Aatrizinventor Solution is prioritized here

(U) Combination of TRIZ innovation parameters shows a match only in the evaluated undesirable effects.

A. PRIORITISED CONTRADICTIONS BY GLOBAL COVERAGE (Cob.GL)

Par.5 is automatically selected

Order	Par.1	Par.2	Par.3	Par.4	Par.5	Cob. NS (%)	Cob. EC (%)	Cob. GL (%)
I.a	6	12	30	36	33. Ease of operation **(E)**	94.82	100	96.12
II.a	12	30	31	36	33. Ease of operation	94.82	100	96.12

III.a	6	12	30	36	20. Use of energy by stationary object **(U)**	88.69	100	91.52
IV.a	6	30	31	36	20. Use of energy by stationary object	88.69	100	91.52
V.a	6	30	31	36	33. Ease of operation	88.68	100	91.51

B. PRIORITIZATION OF CONTRADICTIONS BY COVERAGE OF NEEDS TO SATISFY (Cob.NS)
Par.5 is automatically selected

Order	Par.1	Par.2	Par.3	Par.4	Par.5	Cob. NS (%)	Cob. EC (%)	Cob. GL (%)	Table VI.A
I.b	6	12	30	36	33. Ease of operation **(E)**	94.82	100	96.12	I.a
II.b	12	30	31	36	33. Ease of operation	94.82	100	96.12	II.a
III.b	12	30	36	0	33. Ease of operation	94.82	19.23	75.93	-
IV.b	6	12	30	36	20. Use of energy by stationary object **(U)**	88.69	100	91.52	III.a
V.b	6	30	31	36	20. Use of energy by stationary object	88.69	100	91.52	IV.a

TABLE VII ESSENTIAL CONTRADICTIONS MATRIX FOR NEEDS TO SATISFY (NS) FOR THE SAME UNDESIRABLE EFFECTS EVALUATED OF: CIRCULAR COOLING DUCT
CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !
Evaluated need to satisfy in this report: **33. Ease of operation**
UDEs: (-) 6. Area of stationary object// (-) 12. Shape / composition / configuration// (+) 30. Object-affected harmful factors// (+) 36. Complexity of Device/ Action

This table allows the Innovation Team to compare the coverages obtained for the evaluated need to satisfy with those of the other defined needs, for the same undesirable effects. This way, they can decide whether to choose any of the suggested innovation parameter combinations here that offer better coverage.

Need to Satisfy	Parameter to improve	Parameter to attenuate or preserve	Contradict. Essential	Cob. NS (%)	Cob. between EC (%)	Cob. GL (%) 3/1
33. Ease of operation	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	94.82	100	96.12
20. Use of energy by stationary object	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	88.69	100	91.52

35. Adaptability or versatility	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	87.74	100	90.8
27. Reliability	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	83.24	100	87.43
16. Duration of action by stationary object	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	80.96	100	85.72
39. Productivity	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	80.39	100	85.29
13. Stability	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	78.93	100	84.2
34. Ease of change, repair or maintain	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	76.53	100	82.4
32. Ease of achieving desired outcome	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	76.04	100	82.03
38. Extent of automation/ autonomy	(-) 12. Shape / composition / configuration	(+) 30. Object-affected harmful factors	[22,1,2,35]	70.36	100	77.77

Table VII shows the essential contradictions obtained for each of the defined Needs to Satisfy, taking into account the same undesirable effects that have been evaluated. This table is based on the calculation of a global coverage (Cob.GL), which is determined by combining two values: the coverage from Table IV (Cob.NS) already explained, and a relative coverage (Cob. between EC) that is obtained in this table VII, when each other comparing the essential contradictions identified for the 10 parameters of Needs to Satisfy.

This global coverage (GL) is based on expert weighting criteria to prioritize the solutions for the different Needs to Satisfy. Experience with aatrizinventor indicates that the most effective solutions are those with higher global coverage, preferably exceeding 90%, if possible.

The Innovation Team may decide if it is appropriate to carry out a new evaluation with another Need to Satisfy, selected from the results provided in Table VII. This decision will be primarily made when the evaluated Need to Satisfy is not ranked in the first position of Table VII. In this table, the position of the evaluated Need to Satisfy is highlighted: 33. Ease of operation.

TABLE VIII. ORDER OF INCIDENCE OF INVENTIVE PRINCIPLES (POS.n)

CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected

by area incompatibility: ¡ Attention Houston, we have a problem !
Participation analysis of inventive principles in TABLE II SPECIFIC CONTRADICTION MATRIX.
Evaluated parameters for Object CIRCULAR COOLING DUCT:
Par. UDEs:
(-) 6. Area of stationary object
(-) 12. Shape / composition / configuration
(+) 30. Object-affected harmful factors
(+) 36. Complexity of Device/ Action
Par. NS: (+) 33. Ease of operation

***: Inventive Principles from the Specific Contradiction Matrix (Table II) not described in the Recommend Solution (Table IX). It is recommended to perform an additional review following the order of position.

Inventive principles of Table II	IP type	Tables	Contradictions
IP.22. Convert harm in benefit (Pos.1)	IP. Str.	II / III /	[Par.30][Par.12][IP(s) : 22,1,3,35] - [Par.12][Par.30][IP(s) : 22,1,2,35] - [Par.36][Par.30][IP(s) : 22,19,29,40] - [Par.30][Par.36][IP(s) : 22,19,29,40] -
IP.27. Cheap Short-Living Objects (Pos.2)	IP. Str.	II / III / IV	[Par.30][Par.6][IP(s) : 27,2,39,35] - [Par.6][Par.30][IP(s) : 27,2,39,35] - [Par.36][Par.33][IP(s) : 27,9,26,24] -
IP.2. Taking out/ Adding (Pos.3)	IP. Str.	II / III / IV	[Par.30][Par.6][IP(s) : 27,2,39,35] - [Par.6][Par.30][IP(s) : 27,2,39,35] - [Par.12][Par.30][IP(s) : 22,1,2,35] - [Par.33][Par.30][IP(s) : 2,25,28,39] - [Par.30][Par.33][IP(s) : 2,25,28,39] -
IP.16. Partial or Excessive Actions (Pos.4)	**IP. Oper.**	II / III / IV	[Par.33][Par.6][IP(s) : 18,16,15,39] - [Par.12][Par.36][IP(s) : 16,29,1,28] - [Par.6][Par.33][IP(s) : 16,4,0,0] -
IP.32. Perception/ Appearance/ Color Changes (Pos.5)	IP. Str.	II / III / IV	[Par.33][Par.36][IP(s) : 32,26,12,17] - [Par.12][Par.33][IP(s) : 32,15,26,0] -
IP.1. Segmenting/ Integrating (Pos.6)	IP. Str.	II / III / IV	[Par.30][Par.12][IP(s) : 22,1,3,35] - [Par.12][Par.30][IP(s) : 22,1,2,35] - [Par.6][Par.36][IP(s) : 1,18,36,0] - [Par.12][Par.36][IP(s) : 16,29,1,28] -
IP.29. Controllable Soft Variables (Pos.7)	IP. Tac.	II / III /	[Par.36][Par.12][IP(s) : 29,13,28,15] - [Par.33][Par.12][IP(s) : 15,34,29,28] - [Par.36][Par.30][IP(s) : 22,19,29,40] - [Par.12][Par.36][IP(s) : 16,29,1,28] - [Par.30][Par.36][IP(s) : 22,19,29,40] -
IP.15. Dynamics (Pos.8)	IP. Str.	II / III / IV	[Par.33][Par.6][IP(s) : 18,16,15,39] - [Par.36][Par.12][IP(s) : 29,13,28,15] - [Par.33][Par.12][IP(s) : 15,34,29,28] - [Par.12][Par.33][IP(s) : 32,15,26,0] -

IP.18. Mechanical Vibrations/ Energy Variations (Pos.9) ***	IP. Tac.	II /	[Par.33][Par.6][IP(s) : 18,16,15,39] - [Par.6][Par.36][IP(s) : 1,18,36,0] -
IP.6. Universality (Pos.10) ***	IP. Tac.	II /	[Par.36][Par.6][IP(s) : 6,36,0,0] -
IP.25. Self-service (Pos.11) ***	**IP. Oper.**	II / IV	[Par.33][Par.30][IP(s) : 2,25,28,39] - [Par.30][Par.33][IP(s) : 2,25,28,39] -
IP.19. Time-Varying Action/ Periodic or Pulsating (Pos.12)	IP. Str.	II / III /	[Par.36][Par.30][IP(s) : 22,19,29,40] - [Par.30][Par.36][IP(s) : 22,19,29,40] -
IP.26. Copying/ Replicating (Pos.13)	IP. Str.	II / III / IV	[Par.33][Par.36][IP(s) : 32,26,12,17] - [Par.12][Par.33][IP(s) : 32,15,26,0] - [Par.36][Par.33][IP(s) : 27,9,26,24] -
IP.36. Phase, State or Condition Transitions (Pos.14) ***	**IP. Oper.**	II /	[Par.36][Par.6][IP(s) : 6,36,0,0] - [Par.6][Par.36][IP(s) : 1,18,36,0] -
IP.28. Mechanics Substitution (Pos.15)	IP. Str.	II / III / IV	[Par.36][Par.12][IP(s) : 29,13,28,15] - [Par.33][Par.12][IP(s) : 15,34,29,28] - [Par.33][Par.30][IP(s) : 2,25,28,39] - [Par.12][Par.36][IP(s) : 16,29,1,28] - [Par.30][Par.33][IP(s) : 2,25,28,39] -
IP.34. Discarding and Recovering (Pos.16) ***	IP. Tac.	II / IV	[Par.33][Par.12][IP(s) : 15,34,29,28] -
IP.13. Reverse or Indirect Action (Pos.17) ***	IP. Str.	II /	[Par.36][Par.12][IP(s) : 29,13,28,15] -
IP.9. Preliminary Anti-action (Pos.18) ***	**IP. Oper.**	II /	[Par.36][Par.33][IP(s) : 27,9,26,24] -
IP.4. Asymmetry/ Symmetry (Pos.19) ***	**IP. Oper.**	II /	[Par.6][Par.33][IP(s) : 16,4,0,0] -
IP.39. Inert Atmosphere / Environment (Pos.20)	**IP. Oper.**	II / III /	[Par.30][Par.6][IP(s) : 27,2,39,35] - [Par.33][Par.6][IP(s) : 18,16,15,39] - [Par.6][Par.30][IP(s) : 27,2,39,35] - [Par.33][Par.30][IP(s) : 2,25,28,39] - [Par.30][Par.33][IP(s) : 2,25,28,39] -
IP.35. Transformation / Parameter Changes (Pos.21)	IP. Str.	II / III / IV	[Par.30][Par.6][IP(s) : 27,2,39,35] - [Par.30][Par.12][IP(s) : 22,1,3,35] - [Par.6][Par.30][IP(s) : 27,2,39,35] - [Par.12][Par.30][IP(s) : 22,1,2,35] -
IP.12. Equipotentiality (Pos.22)	IP. Tac.	II / IV	[Par.33][Par.36][IP(s) : 32,26,12,17] -
IP.3. Local Quality (Pos.23) ***	IP. Str.	II / IV	[Par.30][Par.12][IP(s) : 22,1,3,35] -

IP.40. Composite Materials/ Conditions (Pos.24)	**IP. Oper.**	II / III / IV	[Par.36][Par.30][IP(s) : 22,19,29,40] - [Par.30][Par.36][IP(s) : 22,19,29,40] -
IP.24. Intermediary (Pos.25) ***	IP. Tac.	II /	[Par.36][Par.33][IP(s) : 27,9,26,24] -
IP.17. Another Dimension or Field (Pos.26)	IP. Tac.	II / IV	[Par.33][Par.36][IP(s) : 32,26,12,17] -

TABLE IX. RECOMMENDED SOLUTION ACCORDING TO THE MOST RELEVANT CONTRADICTIONS IDENTIFIED FOR THE EVALUATED OBJECT: CIRCULAR COOLING DUCT

CHALLENGE: Improve Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !

This table displays the relevant contradictions identified by the algorithm, which are crucial for determining the direction and scope of the solution to the innovation challenge under evaluation. The specific solution will be obtained by applying the updated inventive principles detailed below.

It is essential to bear in mind that we are evaluating CIRCULAR COOLING DUCT when it interacts with SQUARE CO2 FILTER and there is an affected function: Connection between the Circular Cooling Duct and the square CO2 filter affected by area incompatibility: ¡ Attention Houston, we have a problem !, in a specific space and time. CIRCULAR COOLING DUCT may require changes in space, time, its physical composition, or its functional characteristic, as well as partial or total replacement with another object or other recommended changes. To emphasize this concept, we mark CIRCULAR COOLING DUCT with an asterisk. Do not read the name of the evaluated object literally; associate it with a possible solution for CIRCULAR COOLING DUCT*.

Each inventive principle described here may contain more than one innovation concept recommended by TRIZ, identified as a, b, c, ..., not all of which are applicable to a specific case under evaluation. The Innovation Team must select those innovation concepts that best relate to the evaluated innovation challenge, based on their own knowledge and the analysis of relational thinking that they must carry out.

Additionally, technological research may be necessary for its solution, as the specific solution recommended by the inventive principles described here likely already exists somewhere in the world. The interpretation of the inventive principles, to apply them specifically to the evaluated case, is a recursive process that generally ranges from strategic to tactical and operational levels. We recommend completing the reading of the inventive principles described below to envision a possible solution and then rereading the principles to reinforce the coherence of the emerging solution. As a result of the finally determined innovation solution, there will be a change in CIRCULAR COOLING DUCT, in a new context guided by the inventive principles, probably not previously imagined.

The Language of Nature's Innovation provides speed and focus for guided and systematic innovation thinking for individuals. The foundation for innovation is a profound understanding of the current situation.

IX.A BASE SOLUTION FOR INNOVATION CHALLENGE FOR THE EVALUATED OBJECT CIRCULAR COOLING DUCT NEED TO SATISFY: 33. Ease of operation

Strategic inventive principles: Str. IP
Tactical inventive principles: Tac. IP
Operative inventive principles: Oper. IP
Pos.n : Order of importance n of an inventive principle included in Table II.

ESSENTIAL CONTRADICTION
Contradiction order wt.1

Parameter to improve: (-) 12. Shape / composition / configuration
TO IMPROVE (UDE): CIRCULAR COOLING DUCT has Less Appropriate shape, composition, or configuration interacting with S2
Parameter to attenuate or preserve: (+) 30. Object-affected harmful factors
TO ATTENUATE OR PRESERVE (UDE): CIRCULAR COOLING DUCT has More Harmful factors affecting it by interacting with S2
Inventive principles IP(s) : [22,1,2,35]
22. Blessing in Disguise, Str. IP (Pos.1):
a. Use harmful factors, or external effects related to harmful factors, for CIRCULAR COOLING DUCT* (particularly, effects of the environment or surroundings) to achieve a positive effect with CIRCULAR COOLING DUCT*.
b. Eliminate a harmful primary action by adding another action to CIRCULAR COOLING DUCT*, which counteracts the harmful action to solve the problem.
c. Amplify a harmful factor or a part of CIRCULAR COOLING DUCT*, to such a degree that it is no longer harmful.
Separation principle for CIRCULAR COOLING DUCT* : Integration in supersystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged
1. Segmenting/ Integrating, Str. IP (Pos.6):
a. Divide CIRCULAR COOLING DUCT* into existing and/or new parts, shapes, phases, states, or conditions.
b. Integrate different parts, shapes, phases, states, or existing or new conditions of a CIRCULAR COOLING DUCT* into a single entity..
c. Make CIRCULAR COOLING DUCT* easy to disassemble or assemble.
d. Increase or reduce the degree of fragmentation or segmentation of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation in space / Separation in subsystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged
2. Taking Out/ Adding, Str. IP (Pos.3):
a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*.

b. Add new parts or properties to CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes
35. Transformation/ Parameter Changes, Str. IP (Pos.21):
a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition / Separation alternative
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security)

COMPLEMENTARY CONTRADICTION 1
Contradiction order wt.2

Parameter to improve: (-) 12. Shape / composition / configuration
TO IMPROVE (UDE): CIRCULAR COOLING DUCT has Less Appropriate shape, composition, or configuration interacting with S2
Parameter to attenuate or preserve: (+) 36. Complexity of Device/ Action
TO ATTENUATE OR PRESERVE (UDE): CIRCULAR COOLING DUCT has More Complexity of equipment or action interacting with S2
Inventive principles IP(s) : [16,29,1,28]
16. Partial or Excessive Actions, Oper. IP (Pos.4):
a. If the goal of CIRCULAR COOLING DUCT* is hard to achieve fully, using a given solution's method; then the problem may be considerably easier to solve, using "slightly less" or "slightly more" of the same method.
Separation principle for CIRCULAR COOLING DUCT* : Separation in time
Solution strategy for CIRCULAR COOLING DUCT* : Improving performance
29. Controllable Soft Variables, Tac. IP (Pos.7):
a. Use external, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) to interact with CIRCULAR COOLING DUCT* facilitating goal fulfillment of the function performed with S2 Object.
b. Make easier CIRCULAR COOLING DUCT* interact with S2 Object using internal, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) available in S1 and / or S2, facilitating goal fulfillment.
Separation principle for CIRCULAR COOLING DUCT* : Separation in time
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged
1. Segmenting/ Integrating, Str. IP (Pos.6):
a. Divide CIRCULAR COOLING DUCT* into existing and/or new parts, shapes, phases, states, or conditions.
b. Integrate different parts, shapes, phases, states, or existing or new conditions of a CIRCULAR

COOLING DUCT* into a single entity..
c. Make CIRCULAR COOLING DUCT* easy to disassemble or assemble.
d. Increase or reduce the degree of fragmentation or segmentation of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation in space / Separation in subsystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged
28. Mechanics Substitution, Str. IP (Pos.15):
a. Replace a direct or manual action in, or for, CIRCULAR COOLING DUCT*, with a mechanical action or a tool.
b. Replace a mechanical means in, or for, CIRCULAR COOLING DUCT*, with sensory (optical, acoustic, vibration, taste, smell, feelings or other sensory fields) means.
c. Use mechanical, pneumatic, hydraulic, electric, magnetic, and electromagnetic, chemical, biological, psychological or other fields to improve action of CIRCULAR COOLING DUCT*.
d. Change from static fields in, or for, CIRCULAR COOLING DUCT* to moving fields, from unstructured fields to those with structure, or vice versa.
e. Use fields in conjunction with field-activated parts, components, or particles (e.g., magnetic field and ferromagnetic particles) in, or for, CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

COMPLEMENTARY CONTRADICTION 2
Contradiction order wt.4

Parameter to improve: (-) 12. Shape / composition / configuration
TO IMPROVE (UDE): CIRCULAR COOLING DUCT has Less Appropriate shape, composition, or configuration interacting with S2
Parameter to attenuate or preserve: (+) 33. Ease of operation
TO PRESERVE (DE): CIRCULAR COOLING DUCT has More Desired ease of operation to interact with S2
Inventive principles IP(s) : [32,15,26,0]
32. Perception/ Appearance/ Color Changes, Str. IP (Pos.5):
a. Change how is perceived, the appearance or shape of CIRCULAR COOLING DUCT* in relation to the object (S2) with which it interacts.
b. Change the color, or appearance, of CIRCULAR COOLING DUCT* or its external environment.
c. Change the transparency of CIRCULAR COOLING DUCT* or its external environment.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged
15. Dynamics, Str. IP (Pos.8):
a. Allow (or design) the characteristics of CIRCULAR COOLING DUCT*, external environment, or process to change to an optimal, or to find an optimal, operating condition.
b. Divide CIRCULAR COOLING DUCT* into parts that are capable of relative movement between each other.
c. If CIRCULAR COOLING DUCT* (or process) is rigid or inflexible, make it flexible or adaptive.
d. To enhance the dynamics of CIRCULAR COOLING DUCT* or the process, use feature(s) or object(s) available in the nearby environment.

Separation principle for CIRCULAR COOLING DUCT* : Separation in time
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged

26. Copying/ Replicating, Str. IP (Pos.13):

a. Instead of using CIRCULAR COOLING DUCT*, or any of its unavailable, expensive, fragile parts or properties, use simpler and inexpensive copies or replicates to perform the desired function and, if possible, do so with improved characteristics and properties, while disregarding the harmful, undesirable, or unnecessary ones.

b. Imitate or replicate CIRCULAR COOLING DUCT*, or any of its parts or properties, leveraging the relevant available environment.

c. If simple copies, or replicates are already being used, apply copies, or replicates of a higher level or technical complexity.

Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged

COMPLEMENTARY CONTRADICTION 3
Contradiction order wt.5

Parameter to improve: (-) 6. Area of stationary object
TO IMPROVE (UDE): CIRCULAR COOLING DUCT has Less Own area or two-dimensional scope interacting with S2
Parameter to attenuate or preserve: (+) 30. Object-affected harmful factors
TO ATTENUATE OR PRESERVE (UDE): CIRCULAR COOLING DUCT has More Harmful factors affecting it by interacting with S2
Inventive principles IP(s) : [27,2,39,35]

27. Cheap Short-Living Objects, Str. IP (Pos.2):

a. Replace or divide (either fully or partially) CIRCULAR COOLING DUCT* or its action with multiple inexpensive or short-living objects, actions, or sub-parts, which compress or simplify its characteristics and properties, and/or are limited but sufficient to achieve the desired objective.

b. Comprising certain qualities of CIRCULAR COOLING DUCT* (e.g., the degree of participation, complexity, or lifetime), with no loss of functionality, to achieve the desired objective.

Separation principle for CIRCULAR COOLING DUCT* : Separation in subsystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security)

2. Taking Out/ Adding, Str. IP (Pos.3):

a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*.

b. Add new parts or properties to CIRCULAR COOLING DUCT*.

Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

39. Inert Atmosphere/ Environment, Oper. IP (Pos.20):

a. Replace a currently harmful or undesirable environment for CIRCULAR COOLING DUCT* with an inert one, either fully or partially.

b. Add neutral parts, or inert additives to CIRCULAR COOLING DUCT* or its environment.

c. Leave the harmful environment for CIRCULAR COOLING DUCT* towards another environment or dimension.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged
35. Transformation/ Parameter Changes, Str. IP (Pos.21):
a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition / Separation alternative
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security)

COMPLEMENTARY CONTRADICTION 4
Contradiction order wt.7

Parameter to improve: (+) 36. Complexity of Device/ Action
TO IMPROVE (UDE): CIRCULAR COOLING DUCT has More Complexity of equipment or action interacting with S2
Parameter to attenuate or preserve: (+) 30. Object-affected harmful factors
TO ATTENUATE OR PRESERVE (UDE): CIRCULAR COOLING DUCT has More Harmful factors affecting it by interacting with S2
Inventive principles IP(s) : [22,19,29,40]
22. Blessing in Disguise, Str. IP (Pos.1):
a. Use harmful factors, or external effects related to harmful factors, for CIRCULAR COOLING DUCT* (particularly, effects of the environment or surroundings) to achieve a positive effect with CIRCULAR COOLING DUCT*.
b. Eliminate a harmful primary action by adding another action to CIRCULAR COOLING DUCT*, which counteracts the harmful action to solve the problem.
c. Amplify a harmful factor or a part of CIRCULAR COOLING DUCT*, to such a degree that it is no longer harmful.
Separation principle for CIRCULAR COOLING DUCT* : Integration in supersystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged
19. Time-Varying Action/ Periodic or Pulsating, Str. IP (Pos.12):
a. Instead of using continuous action in, or for, CIRCULAR COOLING DUCT*, , use time-varying, periodic, or pulsating actions.
b. If the action of CIRCULAR COOLING DUCT* is already periodic, change the periodic magnitude or frequency.
c. Use pauses between impulses to perform a different action of CIRCULAR COOLING DUCT*.
d. If the current action of CIRCULAR COOLING DUCT* is time-varying, and if necessary, change to an action higher or lesser time-varying.

Separation principle for CIRCULAR COOLING DUCT* : Separation in time
Solution strategy for CIRCULAR COOLING DUCT* : Improving performance

29. Controllable Soft Variables, Tac. IP (Pos.7):

a. Use external, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) to interact with CIRCULAR COOLING DUCT* facilitating goal fulfillment of the function performed with S2 Object.

b. Make easier CIRCULAR COOLING DUCT* interact with S2 Object using internal, controllable soft variables (manual, physical, mechanical, pneumatic, hydraulic, electrical, magnetic, electromagnetic, digital, chemical, biological, social, psychological, physiological , etc.) available in S1 and / or S2, facilitating goal fulfillment.

Separation principle for CIRCULAR COOLING DUCT* : Separation in time
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged

40. Composite Materials/ Conditions, Oper. IP (Pos.24):

a. Change from a uniform material, property, state, or condition in, or for, CIRCULAR COOLING DUCT* , to a composite one, or vice versa.

Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

IX.B SOLUTION TO MORE RELEVANT CONTRADICTIONS BETWEEN NEEDS TO SATISFY (Cob.NS)

Included in each inventive principle described below is the incidence level or position number it occupies in Table II. If it is not shown, it means that it only appears in Table IV. and requires attention.

CONTRADICTION BETWEEN NEEDS TO SATISFY N° 1

Parameter to improve 33. Ease of operation

IMPROVE: CIRCULAR COOLING DUCT tiene More Desired ease of operation to interact with S2

Parameter to preserve 32. Ease of achieving desired outcome

PRESERVE: CIRCULAR COOLING DUCT tiene más efecto deseable por párametro 32. Ease of achieving desired outcome

Inventive principles IP(s) : [2,5,12,0]

2. Taking Out/ Adding, Str. IP (Pos.3):

a. Separate an interfering part or a property from CIRCULAR COOLING DUCT*, or single out the only necessary part (or property) of CIRCULAR COOLING DUCT*.

b. Add new parts or properties to CIRCULAR COOLING DUCT*.

Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

5. Merging/ Separating, Str. IP (Pos.):

a. Bring CIRCULAR COOLING DUCT* closer or merge with other objects with similar or identical operations or functions.

b. Bring CIRCULAR COOLING DUCT* closer or merge with other objects with similar operations or functions so that they can act together at the same time.

c. If there are objects fused to CIRCULAR COOLING DUCT*, and if necessary, apply a separation action.

d. If objects are merged, and if necessary, apply a separation action.

Separation principle for CIRCULAR COOLING DUCT* : Integration in supersystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

12.- Equipotentiality, Tac. IP (Pos.22):

a. In a potential field, limit position changes or energy variations of CIRCULAR COOLING DUCT*.
b. Change operating conditions to eliminate the need to change the position or energy quality of CIRCULAR COOLING DUCT* in a potential field.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition to satisfy contradiction
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged

CONTRADICTION BETWEEN NEEDS TO SATISFY Nº 2
Parameter to improve 33. Ease of operation
IMPROVE: CIRCULAR COOLING DUCT tiene More Desired ease of operation to interact with S2
Parameter to preserve 27. Reliability
PRESERVE: CIRCULAR COOLING DUCT tiene más efecto deseable por párametro 27. Reliability
Inventive principles IP(s) : [17,27,8,40]
17. Another Dimension or Field, Tac. IP (Pos.26):
a. Add or remove physical dimensions or fields of action of CIRCULAR COOLING DUCT*.
b. Move CIRCULAR COOLING DUCT* to a new dimension in space or performance field.
c. Use for CIRCULAR COOLING DUCT* multi-story arrangement of objects instead of a single-story arrangement.
d. Tilt or re-orient CIRCULAR COOLING DUCT*; lay it on its side.
e. Use another side of a given dimension or field of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving performance; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security); Improving if a solution has not yet emerged
27. Cheap Short-Living Objects, Str. IP (Pos.2):
a. Replace or divide (either fully or partially) CIRCULAR COOLING DUCT* or its action with multiple inexpensive or short-living objects, actions, or sub-parts, which compress or simplify its characteristics and properties, and/or are limited but sufficient to achieve the desired objective.
b. Comprising certain qualities of CIRCULAR COOLING DUCT* (e.g., the degree of participation, complexity, or lifetime), with no loss of functionality, to achieve the desired objective.
Separation principle for CIRCULAR COOLING DUCT* : Separation in subsystem
Solution strategy for CIRCULAR COOLING DUCT* : Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security)
8. Anti-weight/ Compensation, Tac. IP (Pos.):
a. To compensate for the heaviness/lightness or incidence of CIRCULAR COOLING DUCT*, merge it with other objects or independent own parts that provide an effect to improve the current situation.
b. To compensate for the heaviness/lightness or incidence of CIRCULAR COOLING DUCT*, make it interact with the environment.
For example, compensate for the heaviness of CIRCULAR COOLING DUCT* subject to a gravitational field, or exposed to a magnetic field, or subject to an economic value or price, or subject to a chemical bond, or subject to intellectual rigidity, a paradigm, or prejudices.
Separation principle for CIRCULAR COOLING DUCT* : Separation alternative
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes
40. Composite Materials/ Conditions, Oper. IP (Pos.24):
a. Change from a uniform material, property, state, or condition in, or for, CIRCULAR COOLING DUCT* ,

to a composite one, or vice versa.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

CONTRADICTION BETWEEN NEEDS TO SATISFY N° 3
Parameter to improve 33. Ease of operation
IMPROVE: CIRCULAR COOLING DUCT tiene More Desired ease of operation to interact with S2
Parameter to preserve 13. Stability
PRESERVE: CIRCULAR COOLING DUCT tiene más efecto deseable por párametro 13. Stability
Inventive principles IP(s) : [32,35,30,0]
32. Perception/ Appearance/ Color Changes, Str. IP (Pos.5):
a. Change how is perceived, the appearance or shape of CIRCULAR COOLING DUCT* in relation to the object (S2) with which it interacts.
b. Change the color, or appearance, of CIRCULAR COOLING DUCT* or its external environment.
c. Change the transparency of CIRCULAR COOLING DUCT* or its external environment.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition
Solution strategy for CIRCULAR COOLING DUCT* : Improving if a solution has not yet emerged
35. Transformation/ Parameter Changes, Str. IP (Pos.21):
a. Change CIRCULAR COOLING DUCT*'s physical or chemical state (e.g., in shape, in composition, to a gas, liquid, solid or plasma).
b. Change the composition or condition of CIRCULAR COOLING DUCT* by adding or removing components.
c. Change the concentration or consistency; change the degree of flexibility; change the temperature or the level of internal activity of CIRCULAR COOLING DUCT*.
Separation principle for CIRCULAR COOLING DUCT* : Separation by condition / Separation alternative
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes; Improving 7 quality factors (Quality, Reliability, Maintainability, Supportability, Human Factors, Safety, Security)
30. Simple Shapes/ Ways to Interact, Tac. IP (Pos.):
a. Use flexible rods and ropes, or another option with similar one-dimensional functionality, or shells and thin films, or another option with similar two-dimensional functionality, for CIRCULAR COOLING DUCT*, instead of complex three-dimensional structures, in type and number of components and shapes.
b. Separate/isolate CIRCULAR COOLING DUCT* from the external environment with simple shapes, using flexible rods and ropes, or another option with similar one-dimensional functionality, or shells and thin films, or another option with similar two-dimensional functionality.
c. Instead of using complex forms or methods with CIRCULAR COOLING DUCT* to interact with S2 Object, one should use simpler ways or methods, employing flexible objects or means, either physical or conceptual, operating predominantly in one or two dimensions, with other dimensions to the minimum. This is in order to reduce the number of resources and actions necessary to achieve the desired objective.
Separation principle for CIRCULAR COOLING DUCT* : Separation in space
Solution strategy for CIRCULAR COOLING DUCT* : Improving attributes

Anexo
List of applicable Inventive Principles for Innovation Solutions

IP.1. Segmenting/ Integrating	IP.21. Skipping/ Avoiding

IP.2. Taking out/ Adding	IP.22. Convert harm in benefit
IP.3. Local Quality	IP.23. Feedback
IP.4. Asymmetry/ Symmetry	IP.24. Intermediary
IP.5. Merging/ Separating	IP.25. Self-service
IP.6. Universality	IP.26. Copying/ Replicating
IP.7. Nesting/ Dispersing	IP.27. Cheap Short-Living Objects
IP.8. Anti-Weight/ Compensation	IP.28. Mechanics Substitution
IP.9. Preliminary Anti-action	IP.29. Controllable Soft Variables
IP.10. Preliminary Action	IP.30. Simple Shapes/ Ways to Interact
IP.11. Beforehand Cushioning	IP.31. 31.Using/ Removing Unused Parts
IP.12. Equipotentiality	IP.32. Perception/ Appearance/ Color Changes
IP.13. Reverse or Indirect Action	IP.33. Homogeneity / Compatibility
IP.14. Spheroidality - Curvature - Angle	IP.34. Discarding and Recovering
IP.15. Dynamics	P.35. Transformation / Parameter Changes
IP.16. Partial or Excessive Actions	IP.36. Phase, State or Condition Transitions
IP.17. Another Dimension or Field	IP.37. Useful Perceptible Change
IP.18. Mechanical Vibrations/ Energy Variations	IP.38. Strong or Quick Reactions
IP.19. Time-Varying Action/ Periodic or Pulsating	IP.39. Inert Atmosphere / Environment
IP.20. Continuity of Useful Action	IP.40. Composite Materials/ Conditions

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