Concepts NREC
The Experts in Turbomachinery

BALLOT FOR DIFFUSER CONSORTIUM, PHASE VII, YEAR 2015

Instructions:

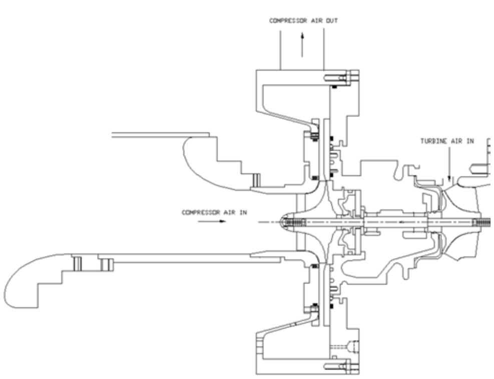
1. Broader Test Base (18)

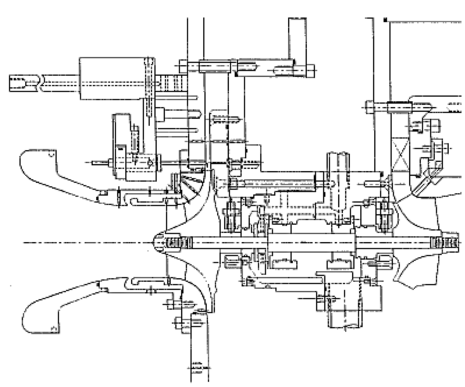
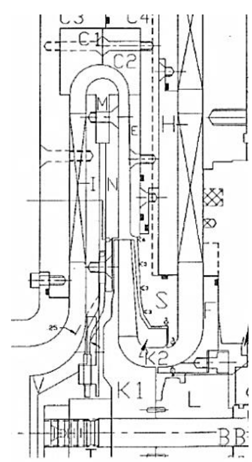
   A number of sponsors and potential sponsors have asked for a broader study base. Work in Phases IV and V established such a base with three different impellers and a wide variety of vaneless, LSA/flat, channel/conical diffusers. With these, it is now possible to:
   Continue High Ns (110) stage (pr = 3.5) for limited tests to complete matrix,
   Pursue pr = 4.5, Ns = 85 stage with a full set of diffusers including conical, and
   Pursue pr = 1.8, Ns = 55 stage with vaneless, LSA, and flat-plate diffusers.

A brief history of some of the diffusers evaluated and opportunity for further investigation is represented in the following chart:

Impeller Type	Testing per Diffuser Class and Type (y - yes; n - no; n/a - not applicable)												Grooved Covers	
	Vnls-f	Vnls-r	Vnls-b	Vnls-pa	Ch-t	Ch-a	Ch-d	Con	LSA	HSA	Tnd	Flat	Vnls	Vaned
Ns = 110, pr = 3.5	y	y	y	n	y	n	y	n	y	n	y	y	y	planned
Ns = 85, pr = 4.5	y	n	n	n	y	n	n	y/n	y	n	n/a	n	n	n
Ns = 55, pr = 1.8	y	n	n	n	n/a	n/a	n/a	n/a	y	n/a	n/a	n	n	n

Vnls-f = front pinch Vaneless	Ch-t = tangential divergence	LSA	= Low Solidity Airfoil
Vnls-r = rear pinch Vaneless	Ch-a = axial divergence	HAS	= High Solidity Airfoil
Vnls-b = both sides pinched	Ch-d = double divergence	TND	= Tandem Airfoils
Vnls-pa = partial height vanes	Con = Circular cross section	FLAT	= Flat Plate LSA equivalent



Once selected, the goal would be to have fairly broad coverage of the best diffusers in each flow coefficient range, so that best practices across the board can be established with and without grooves or other cover treatments. The highlighted elements of the table above may hold

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promise for future development; y or yes indicates that tests have been done and n or no means that no tests have been done.

2. Best Diffusers (4)
   Study the set of best diffusers, and postulate a hybrid with the best characteristics of several. Design and test. For the vaneless case, find the key limits on low flow operation, and move them lower, if possible.
3. Extended Range (3)
   In addition to flow-wise grooves, other treatments are available to improve operating range, such as impeller tip plenums, circumferential grooves, slotted inducer tip treatment, and classical cover bleed, all of which have shown successes. Establish which of these can be combined with flow-wise grooves to extend the stable operating range of both vaneless and vaned diffusers.
4. Grooved covers (3)
   Flow-wise grooved covers have shown promise. To continue this effort, prepare a best grooved cover (range and efficiency improvement) for two stages and continue the study; these may be for the Ns = 55 and Ns = 85 stages and may involve rear side grooves, as well as front cover grooves.
5. Detailed Exit Flow Study, Vaneless (4)
   Study detailed clearance and passage plus grooved flows at impeller exit and diffuser inlet with L2F with a vaneless diffuser. Conduct L2F measurements for a stage on the largest consortium rig, ca. 125 mm D2. Evaluate data and test modeling with CFD.
6. Detailed Exit Flow Study, Vaned (5)
   Study detailed clearance and passage plus grooved flow at impeller exit and diffuser inlet with L2F with a vaned diffuser. Conduct L2F measurements for a stage on the largest consortium rig, ca. 125 mm D2. Evaluate data and test modeling with CFD.
7. Time-accurate CFD (3)
   Assess practicality of existing codes to correctly resolve clearance and grooved flow issues. Assess means of extending codes. Pursue rational extensions of existing codes to deal with two frames of reference.
8. Volute Design (4)
   Add a symmetric or an overhung volute, designed in part by MDO, to give the best area and radius distributions and tongue shape. Test in vaneless mode. Use laser sintering to produce volute.
9. Impeller Meanline Modeling (3)
   Update two-elements-in-series (TEIS) models for impellers. Revise correlations and update design database. Explore impeller and diffuser coupling effects on TEIS parameters for enhanced modeling capabilities.
10. Diffuser Meanline Modeling (3)
   Update TEIS models for diffusers. Study behavior in new test data and compare to existing correlations. Add test data to design database and validate models. Improve numerical modeling capabilities for wider range of stationary vaned diffusing elements.

Ten areas of possible work are outlined above, each with a number behind it in parenthesis, which gives the estimated number of sponsors required to do the work for a one-year effort. For example, with the current 18 sponsors, we could do item 1 over two years at 9 per year, plus items 5 and 6 in one year, and items 2 and 4 over the next year, and possible squeeze in one more. Our experience however indicates that participation usually rises at this point in a diffuser program. A fuller set of 25 sponsors (which is likely) gives 50 units over two years that will cover all the work outlined above.

This is the first of several ballots that will be used before the team digs deeply into Phase VII work. We cannot sequence both breadth and depth in a rigorous manner, so several Questionnaires/Ballots will be used over the next couple of months.

Please take a few moments to give your first reaction to the attached voting. If you change your mind a week later, just re-vote and then send us a new questionnaire/ballot! (Better than most national elections!!)

1. Please rank-order your preferences, with 1 being the highest priority and 10 being your last priority. You may add other choices as you wish and include them in the ranking:

    1. Broader Test Base (3 stages) [ ]
    2. Best Diffusers [ ]
    3. Extended Range [ ]
    4. Grooved Covers [ ]
    5. Vaneless L2F [ ]
    6. Vaned L2F [ ]
    7. Time-accurate CFD [ ]
    8. Volute Design [ ]
    9. Impeller Meanline Modeling [ ]
    10. Diffuser Meanline Modeling [ ]

2. The classes of diffusers you are most likely to use over the next seven years are (rank order 1- most likely, 9 - least likely):

    1. Vaneless without Pinch [ ]
    2. Vaneless with Pinch [ ]
    3. LSA [ ]
    4. HSA [ ]
    5. Flat-plate [ ]
    6. Channel – Tangential Divergence [ ]
    7. Channel – Axial or Double Divergence [ ]
    8. Conical [ ]
    9. Other (specify________________________) [ ]

3. What are the most important objectives for your future diffusers (1 –highest, 4 – lowest):

    1. High Efficiency [ ]
    2. Wide Operating Range [ ]
    3. Cost Reduction [ ]
    4. Noise Reduction [ ]

4. What is the best split in use of resources between acquiring laboratory data and CFD?

    1. Laboratory Data [ ]%
    2. CFD Investigations [ ]%

5. We use written reports, webinars, an annual meeting, and a world tour to present and discuss results and findings. Please evaluate these for us by ranking them by usefulness (1 – most useful; 4 – least effective for you)

    1. Written reports [ ]
    2. Webinars [ ]
    3. Annual Meeting [ ]
    4. World Tour [ ]
    5. Other comments: ____
    ____

6. Please list any other items which should be included in our next questionnaire____