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PASSIVE ROCKET DIFFUSER TESTING:
REACTING FLOW PERFORMANCE OF ADVANCED CONFIGURATIONS

By Daniel R. Jones

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Stennis Space Center, Ms.



WASHINGTON

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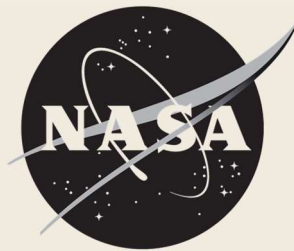
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"...for the benefit of all mankind."

National Aeronautics and Space Act of 1958

PREFACE

This report was written for a technical audience interested in the design of supersonic diffusers, but its content underpins ongoing spike ejector research expected to have broad appeal across multiple industrial sectors. It is intended to serve as a reference for interpretation of experimental data, to show the empirical limits of conventional design, and to describe some research and development work on higher-performance alternatives. The information density of graphics is far greater than that of prose. As such, the reader is encouraged to peruse the figures on pages 19-40 before reading past the background section of the text.

While its format pays homage to the government reports of the 1940s-1960s, this document was created with digital consumption in mind. Plots have been embedded in vector format to allow a high degree of magnification. Axis scales were kept constant on a per-figure basis unless otherwise noted, and repetitious labeling was omitted to keep the focus on qualitative differences between configurations. An effort was also made to keep plot markers consistent throughout the paper so that Figure 3 effectively serves as the legend for the rest.

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ABSTRACT

Upper stage rocket engines are optimized for operation at the edge of space. Ground testing often requires simulation of high-altitude environments to prevent damage from off-design operation. Passive supersonic diffusers are an effective means of establishing the partial vacuum needed around the nozzle exit. The low cost of diffusers relative to active vacuum sources (ejectors, pumps, etc.) provides a perpetual incentive to improve their performance and expand the envelope of passively testable engines. Second-throat diffusers have been the de facto standard for rocket testing since the 1950s, and numerous studies have focused on parametric optimization of the topology. Yet, even the best second-throat designs may require more driving pressure than an upper stage engine can provide. To overcome conventional limits, engineers at NASA's Stennis Space Center (SSC) adapted an obscure cold-flow diffuser topology to the extremes of immersion in supersonic combustion products. Aerodynamic experimentation was conducted at SSC's E-3 test stand to quantify the performance of prototypical hot-fire spike diffuser hardware and enable direct comparison to prior states of the art.

A LO_x/GH₂ thruster was contoured to approximate the regeneratively-cooled nozzle of an upper-stage engine and fired into 28 downstream diffuser configurations: 16 second-throat, 2 centerbody, and 10 spike. Temperature and pressure were recorded along the test article walls for a range of chamber pressures spanning 3.5 - 5.0 MPa. The second-throat configurations with the lowest start and unstart pressure ratios were shown to outperform equivalent systems in literature and taken as baselines for evaluation of advanced diffuser performance. Compared to these exemplars, centerbody diffusers decreased start pressure ratio by 11% but increased unstart pressure ratio by 15%. Spike diffusers reduced start and unstart pressure ratios by 24% and 9%, respectively.

BACKGROUND

The nozzles of upper stage rocket engines are designed to expand combustion products to the low pressures found at the edge of Earth's atmosphere. Ground testing such engines in open air would overexpand the plume and risk nozzle damage from unsteady boundary layer separation. Test facilities typically incorporate some means of back pressure reduction to avoid separation during steady operation. Active, externally powered vacuum sources (encapsulating chambers, steam ejectors, etc.) may be feasible for testing low mass-flow rockets but infrastructure and operating costs can become prohibitive at larger scales. Conversely, passive rocket diffusers harness the internal power of the exhaust plume and force it to act as a jet pump for the area surrounding the nozzle.

In 1958, NASA's Langley Research Center (LaRC) drew on the data and designs of both supersonic wind tunnels and air ejectors when creating the first diffuser designed explicitly for ground testing upper stage rockets [1]. Other facilities followed suit and the cylindrical and second-throat topologies common to earlier applications quickly became the industry norm [2-9]. While both topologies are simple

and reliable, neither are particularly efficient because they permit high stagnation pressure losses to occur through Mach reflection of the core flow.

By 1960, it was realized that the addition of an aerodynamic centerbody could decrease shock losses by enabling selective expansion of the plume [9]. It was also found that annular flow forced more reflections (thus more recompression) to occur per unit length, allowing centerbody systems to operate efficiently in half the space of equivalent second-throat systems. Despite a comparatively limited number of deployments, centerbody diffusers have been evaluated in subscale experiments and implemented in full-scale tests of both developmental and flight engines [9-20].

Though it was a clear advancement over conventional diffusers, the centerbody topology also introduced two new sources of stagnation pressure loss: one set of shocks created by deflection of the core flow around the nosecone, and a second set created by returning the flow to an axial orientation through the diffuser throat. The first is inherent and easily justified; the conical shocks generated by the presence of the nosecone are weaker than the normal shocks that would occur in its absence. The second is strictly conventional; the losses from the second set of shocks would be avoided if the flow trajectory was held constant through the terminal shock. Any desired turning could be accomplished downstream in the subsonic portion of the diffuser.

In 1962, NASA's Lewis Research Center (LeRC) introduced the spike diffuser as a convenient geometry to evaluate the performance benefits of a variable-area throat in cold-flow experiments [21]. The idea was that the spike could translate forward after passing the initial shock wave at start and reduce the throat area for higher-efficiency steady operation. One byproduct of the topology was the removal of the second set of turning shocks present in centerbody configurations. The experiment was successful, and the variable-area spike diffuser was shown to provide 26% and 40% improvements in start and unstart pressure ratios, respectively. A decade later, cold-flow experimentation conducted by the U.S. Air Force on variable-area ejectors showed a similar magnitude of improvement for low-expansion jet nozzles [22-23].

Despite their aerodynamic efficiency, variable-area diffusers are suboptimal for testing rocket engines. Moving components carry higher risk of failure than their static equivalents, and modern programs are hesitant to accept any facility-induced risk to flight hardware. This is especially true if the parts need to maneuver within the volume of the nozzle, which may itself be moving due to gimbal, unsteady side loads, thermal expansion/contraction of the stage, or flex in the thrust structure. However, a static spike diffuser designed to deliver high performance in a reacting-flow environment would be tenable.

The motivation to develop a hot-fire spike diffuser came in 2018 when a preliminary subscale test series conducted at SSC found that conventional second-throat diffusers would provide insufficient start performance for passive testing of a specific upper stage. To avoid the expense of steam ejection, the program granted leeway to explore unconventional designs. The author happened upon the 1962 LeRC paper during literature review and decided to adapt the spike topology to the unique demands of rocket testing. An aerodynamic contour was designed using computational fluid dynamics (CFD) simulations, a subscale test article was fabricated to fit the existing LO_x/GH₂ thruster, and NASA submitted a patent application to

cover the new capability [24]. A second subscale campaign was conducted during 2021 in which the rocket-tailored spike diffuser was put to the test alongside second throat and centerbody counterparts. This report describes the cumulative results of both test series and contextualizes them against an extensive backdrop of diffuser performance data aggregated from literature.

APPARATUS

The Diagnostic Testbed Facility (DTF) thruster installed at E-3 was designed at NASA's Marshall Space Flight Center (MSFC) in the 1960s and subsequently deployed at SSC as a subscale Space Shuttle Main Engine (SSME) plume simulator [25]. The thruster features an interchangeable copper liner which allows reconfiguration of the nozzle contour as needed. Figure 1 shows the two nozzles used for this test series. Each nominally produced 3.5 kN of thrust at a chamber pressure of 4.38 MPa. One nozzle was conventionally machined with a truncated copper liner and a steel nozzle extension. The other was additively manufactured of GRCop-42 via Direct Metal Laser Sintering (DMLS) and finished with the Hot Isostatic Pressing (HIP) process. The combustion chamber of the DMLS nozzle was shortened and included integral water cooling passages. The two subscale nozzles' expansion contours were identical apart from a 0.14 cm outward step between the copper liner and steel extension which accounted for the materials' disparate coefficients of thermal expansion. As-built geometry and performance characteristics are given in Tables 1.1 and 1.2. A void was milled into the nozzle flanges to serve as a test cell volume. Propellant mixture ratios are provided on per-diffuser basis later in the paper.

Diffuser aerodynamic design was accomplished by Reynolds-Averaged Navier-Stokes simulations using the Loci/CHEM solver [26-27] with finite-rate chemistry [28], $k-\omega$ turbulence modeling [29], compressibility correction [30], wall functions, and a calorically-imperfect ideal-gas equation of state. Diffuser contours were subject to a set of constraints expected to apply during full-scale stage testing, including maximum length and diameter, minimum turning radii for backside cooling, and minimum clearance during engine gimbal. Subscale diffuser hardware was machined from 304 stainless steel and thermal damage was mitigated by limited test duration (1-5s) rather than active cooling. Modularity simplified reconfiguration and allowed broader investigation of the trade space. Two series of instrumentation bosses were run along opposing sides of each diffuser, with one side dedicated to Stellar GT200-20A-155 pressure transducers and the other to Medtherm TCS-061-K-1.5-10F-36-11038 microsecond-response thermocouples. Calibration reports showed measurement accuracies of ± 345 Pa and ± 1.94 K, respectively. All sensors were sampled at 250 Hz. Heat flux densities were processed from thermocouple data using the Cook-Felderman technique [31].

RESULTS AND DISCUSSION

Second-Throat Configurations

Hardware components of the second-throat diffusers are depicted in Figure 2. The design philosophy of inlets A and B drew on lessons learned from a test series conducted at SSC in 2015 [32] which had a high pressure ratio budget, notable length constraints, and a primary objective of producing zero flow separation within the diffuser. The idea was that a cylindrical segment upstream of the contraction would decrease the plume's impingement angle during steady-state operation, conserve stagnation pressure, and delay boundary layer separation. While that was borne out by testing, increased volume upstream of the throat can decrease subsonic pumping efficiency and delay start. This effect has been demonstrated implicitly in contraction spacing studies which used translatable inserts inside cylindrical ducts [7,33]. Taking this into account, inlet C was fabricated with 32% less volume than inlet A. Though the referenced data suggests retaining a short cylindrical segment can be beneficial, a purely conical geometry was adopted to simplify construction.

In general, smaller second-throat areas produce better pumping performance [7,9,33,34]. However, any stagnation pressure losses incurred between the first (nozzle) and second (diffuser) throats increase the area required to pass the system's mass flow rate. During the diffuser startup process, a complex series of shock waves propagates between the two throats. The cumulative losses are commonly but conservatively approximated by assuming a normal shock sitting at the diffuser inlet. This is effectively a worst-case condition invoking losses at the highest Mach number and through the strongest type of shock. It is advantageous to have a higher-fidelity approximation of the starting flow structure when pursuing optimum performance. In this case, CFD simulation was used to estimate the losses and size the second-throat appropriately. The contraction ratio (A_{DT}/A_{DI}) varied between 15% and 20% below the normal shock limit of 0.57, depending on the inlet.

Determining an appropriate second-throat length for optimum start/unstart performance is comparatively straightforward. For hot-fire diffusers, ensuring enough shock reflections to recompress the flow only requires a throat length-to-diameter ratio of 1-3 [1, 6, 8, 32]. Additional length buys unstart performance [8] but increases stagnation pressure lost to shocks and viscous effects. Above a ratio of 8, return on investment decreases [8]. Throat spools D and E were fabricated with length-to-diameter ratio of 7.8 and 1.7 to resolve these effects.

Constraints on spatial envelope left few design choices for the subsonic diffuser. Component F simply represents what would fit on the full-scale test stand.

These components were assembled into sixteen configurations and subjected to aerodynamic experimentation. Geometric and performance characteristics of the tested second-throat configurations are listed in Table 2. Assemblies ADF (inlet A coupled with second throat D and subsonic diffuser F), CDF, and BE were prototypes for different facility concepts. All others were byproducts of modular construction and a recognition that sensitivity studies are particularly valuable in the sparsely explored rocket diffuser trade space. AE and BE were omitted from the test matrix when CE did not start at the maximum chamber pressure deliverable at the time.

Because the test cell lies at the interface between the nozzle and diffuser, its instrumentation can provide a wealth of information on plume development in the coupled system. Plots of test cell pressure variation with chamber pressure, known as pumpdown curves, are a practical way to display that information. Pumpdown curves within literature tend to represent an idealized test in which the cell pressure is given ample time to react to incremental chamber pressure changes. Figure 3, intended to serve as a quick reference for diffuser diagnostics, takes a different approach. Its nominal pumpdown plot shows idealized curves representing multiple runs targeting different chamber pressures with changes in the driving flow occurring quicker than the test cell can respond. The timescale disparity produces fanning of the evacuation and recompression curves during start and unstart. The corresponding off-nominal plot shows idealized curves representing multiple runs, each with a different cause of undesirable behavior.

Configuration CDF received the greatest scrutiny during testing. It was the only diffuser tested with different chamber pressure ramp rates (dP_{CC}/dt) and both the conventionally-machined and DMLS nozzles. Figure 4 depicts typical fast and slow thruster transients and shows its tendency to produce higher ramp rates when targeting higher chamber pressures. Shutdown profiles are also given. The pumpdown curves produced by CDF in response to the various nozzle and transient combinations are plotted in Figure 5. The effect of higher chamber pressure ramp rate was a distortion of the idealized curves; diffuser start and unstart pressure ratios were unchanged but evacuation of the test cell lagged plume development. The shorter chamber of the DMLS nozzle produced a 4% decrease in combustion efficiency which was enough to induce a second-throat-area non-start condition. This data is unique; it is quite unusual to have two nearly-identical nozzles with differing combustion efficiencies coupled with the same diffuser designed so close to the area limit that the combustion efficiency would be relevant. Taken collectively, the CDF data demonstrates the importance of slower chamber pressure ramp rates and complete combustion when attempting to experimentally resolve the pumpdown process. Testing of all other configurations employed the conventionally-machined nozzle.

Pumpdown curves of all starting second-throat diffusers are compared in Figure 6. Data was plotted without smoothing or down sampling. Density of points provides qualitative insight on how quickly the system moved through a given portion of the curve and how much variation occurred test-to-test. Nominal plume development followed the pattern described in Figure 3 with the individual curves stretched or compressed along the dimension of driving pressure ratio according to the diffuser's performance. Off-nominal plots include oscillatory pseudo-starts resulting from insufficient throat length (AF, B, BF, C, CF) and non-starts resulting from insufficient pressure ratio (all others).

Relative performance of the three inlet geometries can be parsed from the data shown. Configurations without a throat spool were too short to achieve absolute start without first pushing through the oscillatory pseudo-start mode. For this subset, diffuser performance was most sensitive to length and inlet A produced the best results. The addition of either throat spool stabilized start behavior and the lower volume of inlet C reliably provided the best performance.

Variation of performance with assembly type is shown in Figure 7. Trends matched expectations. Standalone inlets gave the worst performance. Improvements in both start and unstart pressure ratios were observed with the attachment of a subsonic diffuser. Further improvement was obtained on both fronts by adding the short throat spool. Switching to the long throat spool improved unstart pressure ratio at the expense of slightly degraded start performance. Removal of the subsonic diffuser universally decreased performance. Figure 8 recasts performance variation in terms of diffuser length. Unstart pressure ratio improved with increased length regardless of assembly type. Start pressure ratio improved through a total-length-to-throat-diameter ratio of 8, then decreased at different rates depending on whether the additional length was dedicated to a subsonic diffuser or a longer throat. Longer diffusers were also noted to be more sensitive to inlet design.

Once a diffuser reaches steady state, pressure measurements along its wall can shed light on the shock structure contained within. This is especially true if the data is used to ground CFD. Meaningful predictive simulations are difficult to achieve because solutions to the Navier-Stokes equations are not unique. In practice, this means that a solver may produce a started, unstarted, or oscillatory solution for a given pressure ratio, and that solution may also be highly path-dependent. An analyst may not be able to tell a priori which would best approximate reality. However, postdictive simulation can enable accurate reconstruction of pressure data and visualization of hot-fire flow fields that would be impossible to produce experimentally. This approach is incredibly useful for understanding diffuser behavior even though it requires some cherry-picking of the CFD results.

Figure 9 shows experimental and simulated steady-state wall pressures for each second-throat diffuser during nominal and off-nominal operation. The plots are accompanied by visualizations of CFD-produced Mach number gradients to show the internal shock structure. Non-started flow fields were effectively identical for all diffusers. A large cap shock was positioned near the exit of the nozzle with RSS reflections [35] extended from the nozzle lip and attached to the diffuser inlet. The started shock structures of the standalone inlet configurations were very similar, the difference being that the shock pushed out into the diffuser inlet just enough to isolate the test cell.

Adding the subsonic diffuser created a different shock structure in each inlet. A cap shock was observed in configuration AF which gave rise to a large subsonic core flow that only managed supersonic reacceleration at the end of its throat. BF produced a regular reflection of the impingement shock, flow separation in the contraction, and a large barrel shock terminating with a Mach disk in the subsonic diffuser. CF produced a Mach reflection of the impingement shock. Downstream flow reaccelerated quickly but separated in its contraction.

With the addition of either throat spool, inlet A reliably produced regular reflections of the impingement shock and inlet C produced Mach reflections. The longer throat spool provided sufficient space for multiple reflections to occur. Configuration BEF behaved similarly to BF, with a regular reflection of the impingement shock, separation in the contraction, and a barrel shock sitting in the throat. The longer throat spool adversely impacted the flow. In BD, separation bubbles formed immediately downstream of impingement and at the transition into

the throat. Mach reflection of the terminal shock occurred $\sim 3/4$ through the throat. In BDF, impingement caused strong separation in the inlet and the flow did not recover until its transition into the throat. The flow separated $\sim 3/4$ through the throat but reattached at its end before separating again in the subsonic diffuser. The unusual shock structure was very repeatable and did not change with increased pressure ratio. In light of the CDF data captured with the DMLS nozzle, it was hypothesized that the higher losses created by inlet B's steeper contraction angle combined with the minor losses induced by the successive additions of throat length were causing the configurations to incrementally approach the minimum second-throat area. Observations were consistent with throat restriction; pressure built upstream of the throat and caused separation in the contraction. CFD simulations failed to capture the nuanced separation behavior exhibited by BD and BDF in their started states.

Temperature measurements can be equally useful in determining the behavior inside a diffuser. It may be impossible to distinguish between centerline Mach and regular reflections from wall pressure data, but the higher radiant heat flux of a Mach disk will show up in temperature data. This effect is visible in several of the peak pressure-normalized heat flux density plots shown at the right of each visualization in Figure 9. The magnitude of peak 0.1-s thermal loads often varied widely along the length of a given diffuser depending on the flow structure. Values typically spanned 5-60 $\text{W}/\text{m}^2\text{-Pa}^{0.8}$ but fluxes as high as 90 $\text{W}/\text{m}^2\text{-Pa}^{0.8}$ were noted in some configurations. The sensors did not necessarily experience peak rates synchronously but the tight agreement between starting and non-starting runs reveals that they primarily occurred immediately prior to start. This makes sense; the non-started shock structure creates a hot subsonic core flow surrounded by annular shock reflections propagating along the diffuser walls. As soon as supersonic flow is established, both temperature and pressure drop, resulting in reduced heat flux to the walls. There are some exceptions to this. For example, if a strong shock forms in the diffuser during steady operation, the started value may be higher than the non-started. The downstream separation shock in configuration CDF is an example.

A few caveats apply to the heat transfer data. Pressure measurements took priority in this test series, and thermocouple installation was performed less rigorously. Upon inspection, some were found to protrude into the flow and were not filed back to flush in the interest of time. As their primary purpose was to prevent test article damage by enabling redlines on temperature, conservative values were not considered problematic. Accordingly, there is some unquantified amount of conservatism in the reported heat flux values.

Photographs of test article hardware are provided in Figure 10.

Centerbody Configurations

A modular approach was also taken in the design of the centerbody diffuser hardware. The centerbody and shell, depicted in Figure 11, were both constructed in removable segments. Each shell segment had two instrumentation ports centered axially and clocked 180° circumferentially. The hollow centerbody was attached to a dedicated shell spool via 45° struts of obround cross-section. Two interchangeable nosecones and the first cylindrical segment featured internal instrumentation bosses. The tip of each nosecone was fitted with a thermocouple. Cables were routed into the centerbody through the struts.

Aerodynamic contours of the two tested configurations are given in Figure 12, with geometric and performance characteristics provided in Table 3. The difference between the nosecones is slight, just enough to provide insight on the sensitivity of the system to the penetration depth into the nozzle. CB-1 started and unstarted occurred at the same pressure ratio. CB-2's 1° increase in nosecone half-angle and resultant decrease in penetration depth increased start pressure ratio and decreased unstart pressure ratio. A general difference in pumpdown efficacy can also be seen in Figure 13; the RSS progression was faster and occurred at lower driving and cell pressures in CB-1.

While the plume development in both configurations broadly followed the same trends described in Figure 3, a few additional features are discernible in the pumpdown curves. Differences arose as the plume began to impinge on the nosecone tip. A bow shock formed around the leading edge and a λ -shock pattern was established on the centerbody in addition to the RSS reflections along the nozzle wall. As the plume continued to push downstream, the RSS tendrils impinged upon the shell wall and evacuated the test cell. Each of these phenomena produced a downward inflection point on the pumpdown curve. Further increase of driving pressure resulted first in full flow of the nozzle and plume attachment on the shell wall, then separation of the boundary layer from the shell and attachment to the centerbody. The shock cells subsequently expanded outward until the plume attached to both walls simultaneously and started the diffuser. This sequence showed up as a 'double-knee' shape in the pumpdown curves. The progression is annotated with illustrations in Figure 13.

In Figure 14, the steady-state pressures of CB-2 represent the two final stages of the sequence. In the non-started case, the plume structure is comparable to a free jet core flow which happens to be wrapped around a centerbody, and the smooth pressure rise along the shell wall suggests that it behaves similarly. No pressure data was captured along the centerbody but CFD indicated a high degree of variation through numerous shock reflections. In the started case, reflection of the impingement shock gave rise to a separation bubble on the centerbody. The flow recovered quickly and terminal separation occurred $\sim 2/3$ through the throat with the shock train remaining attached to the centerbody wall. CB-1 was not tested at steady non-started conditions. In the started case, the small change in nosecone geometry produced significant differences in the shock structure, with boundary layer separation occurring further upstream and higher wall temperatures observed throughout the throat (not shown).

Normalized rates of heat transfer were comparable in magnitude to second-throat configurations, with peaks of $20\text{-}60\text{ W/m}^2\text{-Pa}^{0.8}$ primarily occurring immediately prior to start. Nosecone tips were an exception; fluxes of $50\text{-}80\text{ W/m}^2\text{-Pa}^{0.8}$ occurred shortly after ignition as plume impingement began. Nevertheless, these higher thermal loads were similar to those in second-throat configurations induced by shock reflections along the wall or Mach disks along the centerline. Cooling would have been readily achievable in a full-scale system. That said, the subscale hardware was uncooled and slight erosion was observed on both nosecones after several tests. Photos of the damage are shown in Figure 15. The damage to nosecone 2 could be described as a slight ripple around the edges of a shallow, previously-molten pool of steel surrounding the thermocouple. Nosecone 1 did not fare as well. Liquid metal began to streak downstream and score small channels into the profile. The damage to both nosecones mostly affected surface texture and did not significantly change their bulk geometries. Testing continued with the objective of assessing any aerodynamic impacts. Though the damage undoubtedly altered the flowfield in its immediate vicinity, no measurable difference in pumpdown efficacy or steady-state flow structure were discernible in the data.

Spike Configurations

Aerodynamic design of the spike diffuser began with modification of the 1962 LeRC topology [21] to make it practical for testing full-scale rockets. The nosecone was blunted to allow backside cooling, the diffuser-inlet-to-nozzle exit ratio was increased to accommodate gimbal, the inlet was flared outward to accommodate high nozzle exit angles, and the subsonic diffuser was routed axially to prevent damage to supporting infrastructure. The spike tip was also positioned upstream of the nozzle exit in order to force the conical shock formation at lower Mach number. Numerous variants of the modified topology were evaluated using Loci/CHEM simulations over the course of an intense two-week design window. Crude manual optimization produced a baseline contour depicted in the drawings of Figure 16.

Each tested configuration was defined by an assembly of six components: one nosecone, one set of spike and shell segments which defined the inlet and throat profiles, another set of spike and shell segments which formed a subsonic diffuser, and one aft support claw which fixed the spike to the shell. Small stacks of washers were inserted between the claw and other components as needed to change spike position. As with the other diffusers, two series of instrumentation bosses were installed on opposing sides, one dedicated to pressure transducers and the other to thermocouples. Three thermocouples were installed in the original steel nosecone of the spike, with one placed at the tip and two along the inlet section. Tip erosion was monitored between tests and the nosecone was refinished with a slightly larger radius once the accumulated damage progressed from pooling around the thermocouple to streaking downstream. The spike was later modified to accept uninstrumented but interchangeable Inconel 718 nosecones of varying tip radii. A set of smaller tailcone segments was also fabricated. Aerodynamic contours of all spike diffuser components are detailed in Figure 17. The baseline configuration was defined by the core spike

and shell components coupled with nosecone 3 and tailcone X, designated SPK-3X in this report.

Table 4 provides a list of all tested assemblies alongside corresponding geometric and performance characteristics. Sensitivities to nosecone blunting and spike position are determinable from the given data. Increases in nosecone radius led to worse start performance but the effect was small. As shown in Figure 18, the degradation between nosecones 1 and 4 was only 2%. Impact on unstart pressure ratio was more significant, with a 5.5% degradation observed. Axial position of the spike was a stronger determinant of performance, as shown in Figure 19. Downstream translation of 0.72 cm from its minimum-starting position produced 7% and 6% degradations in start and unstart pressure ratio, respectively. Moving the spike upstream of the minimum precluded start and tripled the steady-state cell pressure. Switching subsonic diffusers from X to Y gave mixed but mostly undesirable results. With nosecone 3, 2.8% and 4.8% increases were observed in start and unstart pressure ratio. With nosecone 4, a 0.8% decrease was noted in start pressure ratio but a 2.6% increase in unstart pressure ratio.

Taken as a group, the spike diffuser variants represented only minor changes to the overall geometry. Differences in performance were also small, with a 9% difference observed between the best- and worst- starting configurations. This consistency is seen in the pumpdown curves of Figure 20. All nominal cases produced the same structural progression observed in the centerbody diffusers, though initial impingement on the flared inlet was less severe and did not produce the 'double-knee'. The spike diffusers were also much more efficient at pre-start pumping; the entire plume development sequence occurred at lower chamber and cell pressure ratios. Another point of note came from the position sensitivity data. As the spike was incrementally moved toward the shell test-to-test, pumping efficacy increased until the throat area reached its minimum limit and starting was no longer possible. This bracketed the spike diffuser's minimum contraction ratio between 0.38 and 0.39.

Consistency was also observed in the steady-state flow fields depicted in Figure 21. All started configurations produced similar shock structures characterized by conical shock propagation from the nosecone to the inlet and 2-3 impingement shock reflections through the annular throat prior to boundary layer separation. The highest degree of variation was observed downstream of separation. Depending on the driving pressure ratio and strength of the incident shock, the plume would detach either solely from the shell or from both walls before reattaching to the spike. Any residual supersonic cells invariably shocked down quickly after reaching the subsonic diffuser. All pressure ratio non-starts exhibited similar behavior as well. The boundary layer separated from both nozzle and spike walls and a large recirculation bubble formed on the spike upstream of the nozzle exit. Reattachment occurred in the diffuser inlet. For all tailcone X configurations but one, the plume detached from the spike and attached to the shell at the transition to the diffuser throat before shocking to subsonic. The plume remained attached to the spike in tailcone Y configurations.

The only standout shock structure was that of the non-start produced by insufficient throat area (SPK-4X, $dx/R_{NE} = -0.029$). Like the second-throat restriction suspected in BDF, pressure buildup in the inlet was needed to pass the mass flow

through the throat. A large separation bubble consumed most of the inlet while an annulus of reflected shocks lined the contraction. Flow regained supersonic conditions in the throat.

Peak normalized rates of heat transfer were asynchronous but invariably prior to start. The nosecone experienced its maximum shortly after ignition as plume impingement began. By contrast, the most intense thermal loads observed downstream in the diffuser occurred immediately prior to start. No strong Mach reflections were present in the steady flow fields to drive heating beyond the pre-start maxima. Rates of $50-70 \text{ W/m}^2\text{-Pa}^{0.8}$ were observed in the instrumented nosecone. With the spike in its baseline position or aft, the thermal environments through the inlet and throat were comparatively benign and the walls experienced $20-50 \text{ W/m}^2\text{-Pa}^{0.8}$. In the aerodynamically-optimum forward position, maximum energy flow into the nosecone was unchanged, but inlet and throat values jumped to $75-125 \text{ W/m}^2\text{-Pa}^{0.8}$. No data was captured in the tailcone segments.

Several photographs taken of the spike diffuser hardware during testing show thermal effects on the hardware and are provided in Figure 22. Featured phenomena include boundary layer separation along the shell wall made visible by external condensation of atmospheric humidity, steel nosecone erosion prior to its refinishing, and bands of discoloration on the polished stainless identifying shock reflections along the spike. Photos of installation and test are also shown.

Performance Comparison

The advanced diffusers described above produce clear aerodynamic benefits over their conventional second-throat counterparts. The large disparities in pumping performance become apparent when the pumpdown curves of each topology's best-starting diffuser are juxtaposed, as in Figure 23. At every point along the curve, the spike diffuser produced better pumping performance than the centerbody, which in turn outperformed the second-throat. As a result, the plume was able to move through its characteristic structural progression at lower driving pressures. SPK-1X demonstrated start/unstart pressure ratio improvements of 24%/23% compared to the best-starting second-throat diffuser (CEF) and 25%/9% compared to the best-unstarting second throat diffuser (CDF). These improvements were accomplished in a compact spatial envelope; SPK-1X was 46% shorter than CEF, 57% shorter than CB-1, and 68% shorter than CDF. By contrast, CB-1 gave modest and mixed results with respective start/unstart improvements of 11%/3% vs. CEF and 12%/-15% vs. CDF.

The pressure-normalized heat fluxes discussed in prior sections are useful for parsing flow structures within a set of similar diffusers. However, raw values are more appropriate for assessing differences between topologies because the advanced diffusers produce the pre-start maxima at lower driving pressures. The most severe absolute rates of heat transfer observed in CEF and CB-1 were comparable. CEF experienced 11.5 MW/m^2 along its inlet while the spike and shell of CB-1 experienced 11.3 MW/m^2 and 11.4 MW/m^2 , respectively. SPK-1X, tested without nosecone instrumentation and only in the forward spike position, sustained a much higher maximum of 19.2 MW/m^2 on its shell. This likely could have been reduced to $\sim 9 \text{ MW/m}^2$ by moving the spike downstream to its baseline position and incurring

start/unstart performance penalties of ~2-3%. SPK-3X was the closest tested configuration. Its nosecone experienced a maximum of 11.9 MW/m², which is only 3.5% higher than CEF's peak heat flux, yet the configuration still provided start/unstart pressure ratio improvements of 22%/21% vs. CEF and 23%/5% vs. CDF. As discussed in prior sections, these heat flux values are quantitatively conservative but, taken qualitatively, can be considered clear evidence that a spike diffuser's thermal loads may be kept on par with those of second-throat topologies without sacrificing augmented aerodynamic performance.

Start Performance: A 30 km Perspective

An extensive literature review was conducted to ensure that the performance gains cited above accurately captured the potential of advanced diffuser topologies. Experimental data was compiled from a variety of additional sources [36-65] to reveal the empirical limits of conventional diffuser design. Key geometric and performance parameters of 1058 distinct configurations were assembled into a database for ease of meta-analysis. While great effort was dedicated to finding and cataloging every relevant data point available to the author, the compendium was not intended to provide an exhaustive review of all diffuser applications. Several criteria were established to keep the database focused on the application of single-engine testing:

Qualifiers

- Determinable geometry.
- Negligible secondary mass flow.
- Starting pressure ratio data.
- Reported inlet Mach number or inlet-to-nozzle-throat area ratio.

Disqualifiers

- Clustered, gimbaled, annular, or asymmetric driving nozzles.
- Diffusers with centerline turns.
- Substantial axial gap between the nozzle exit and diffuser inlet.
- Steam as the motive fluid.

The decision to exclude systems driven by steam may seem counterintuitive given that most rockets generate copious amounts in their exhaust, but its expansion is dominated by multiphase effects even when superheated in the chamber. In practical terms, maintaining single-phase steam through a rocket-like expansion process requires a rocket-like combustion process upstream.

Diffuser inlet conditions were used in the performance database to contextualize start and unstart pressure ratios of all configurations. If either the inlet Mach number or area ratio were unreported in the original source, a quasi-one-dimensional calculation was performed to fill in the missing value. For non-reacting flows, this was done with the isentropic relations [66] using a fixed isentropic exponent. For reacting flows, NASA's Chemical Equilibrium with Applications (CEA) code [67] was used. Data was sorted by motive fluid into four groups: solid propellants, common liquid propellants and ethane, air/nitrogen, and everything else. Ethane's conspicuous inclusion among the common liquid propellants is explained by the author in previous memoranda [44, 68]. Frontiers of empirically-demonstrated performance were found for cylindrical and second-throat topologies on a per-group basis, as applicable. Configuration CEF defines the frontier of second-throat start

performance at its Mach number and area ratio. This is easily seen in Figure 24, where the full database of start pressure ratios is plotted against diffuser inlet conditions to give a sense of how performance varies with motive fluid, as viewed from fluidic and geometric perspectives. Given this broader context, the author is confident that CEF is an exemplary representative of conventional diffuser design and is an appropriate standard to which advanced diffusers may be compared. Figure 25 plots all known advanced diffuser data against the same cylindrical and second-throat frontiers. The centerbody and spike diffusers presented in this study sit comfortably below the conventional curves. All other hot-fire/ethane advanced diffuser data points are tied to unpublished relatives of the present study, with the exception of one centerbody configuration used by the German Aerospace Center (DLR) to test the Vulcain engine [13-16]. All plotted data is available in Tables 5-7.

LOOKING FORWARD

Design time for the advanced diffusers featured in this report was notably constrained, and the contours were products of rudimentary manual optimization. More rigorous techniques may further enhance aerodynamic performance. It is also noted that the stagnation pressure saved by forcing a conical shock at the diffuser inlet would increase with higher Mach number and lower isentropic exponent. This has significant implications for applications beyond rocket testing. On the high-Mach side, one could easily imagine implementation in hypersonic wind tunnels (many still use constant-area diffusers), or in industrial multistage ejector systems. On the low-isentropic-exponent side, ejector-based refrigeration cycles could see particular benefit. SSC is currently developing spike-based air and steam ejectors intended to reduce the operating costs of NASA's current and future facilities.

CONCLUDING REMARKS

Performance characteristics of second-throat, centerbody, and spike diffusers have been experimentally assessed in pursuit of economical means of upper-stage rocket engine testing. Extensive literature review has been conducted to ensure exemplary second-throat diffuser performance and enable fair, direct comparison between topologies. Starting pressure ratio reductions of 11% and 24% were achieved with centerbody and spike configurations, respectively. Peak heat fluxes observed within the spike diffuser were particularly high in the aerodynamically-optimum configuration operating just above the minimum throat area. This was alleviated by shifting the spike slightly downstream. The shifted configuration started at a pressure ratio 22% lower and experienced a maximum heat flux 3.5% higher than the best conventional design.

NOMENCLATURE

| | | | |
|------|--|----------|-----------------------------|
| A | Area | R | Radius |
| c* | Characteristic Velocity | RSS | Restricted Shock Separation |
| CON | Conical Geometry | T | Temperature |
| D | Diameter | t | Time |
| FAIR | Nozzle with fairing attached to produce axial exit flow | TIC | Truncated Ideal Contour |
| FSS | Free Shock Separation | TOC | Thrust Optimized Contour |
| L | Length | TOP | Thrust Optimized Parabolic |
| M | Mach Number | WT | Wind Tunnel |
| NR | Not Reported | x | Axial Position |
| O:F | Oxidizer-to-Fuel Mass Ratio | γ | Isentropic Exponent |
| P | Pressure | Δ | Nosecone Penetration Depth |
| | | θ | Angle |

Subscripts

| | | | |
|------|--|------|--------------------------------------|
| O | Stagnation Condition | DT | Diffuser Throat |
| BACK | External Condition at Diffuser Exit | MIN | Minimum |
| BODY | Throat Portion of Centerbody | NC | Nosecone |
| CB | Centerbody | NE | Nozzle Exit |
| CC | Combustion Chamber | NT | Nozzle Throat |
| CELL | Test Cell | SPK | Spike |
| CYL | Cylindrical | ST | Second Throat |
| D | Diffuser | SUB | Subsonic |
| DI | Diffuser Inlet | TIP | Tip of Nosecone |
| | | TAIL | Tapered Aft Section of Centerbody |

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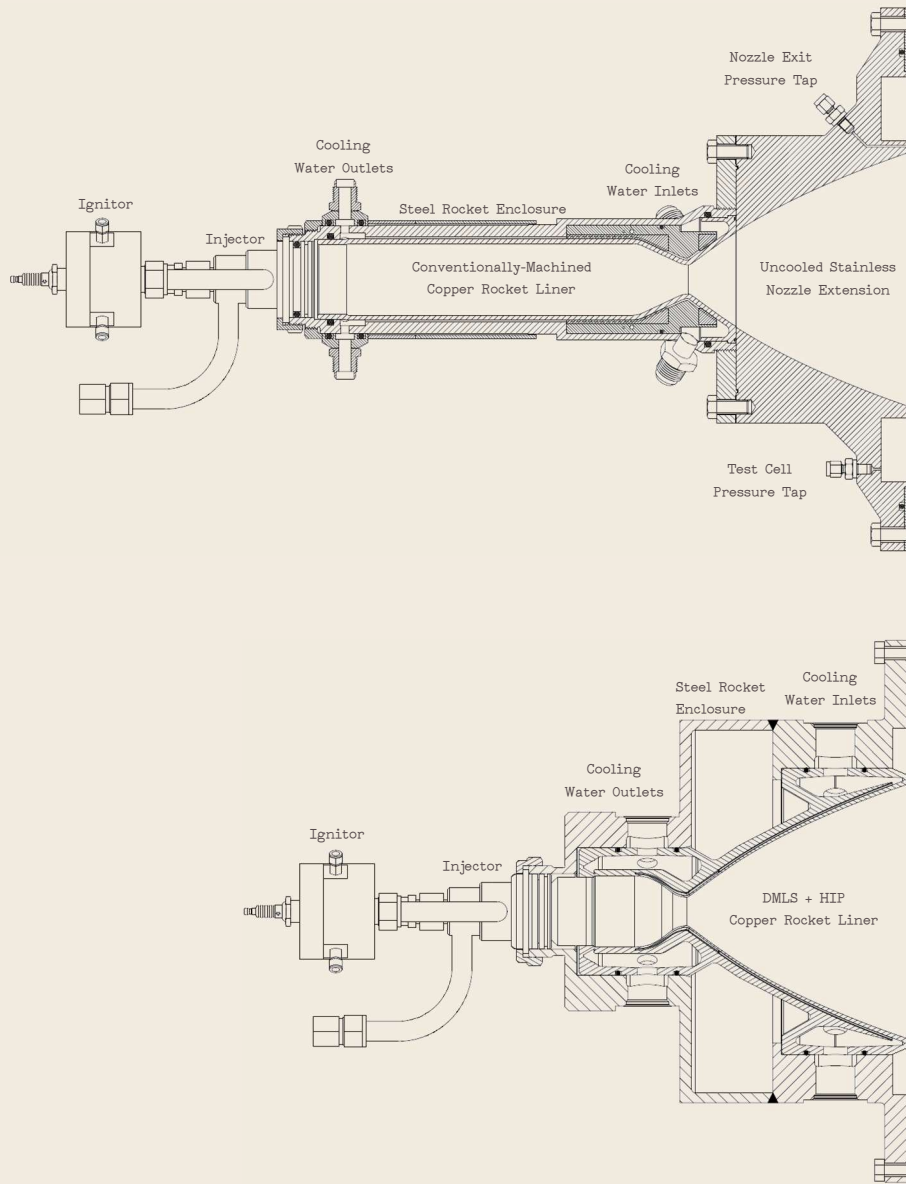


Figure 1. Cross-sections of DTF Thruster nozzle assemblies.

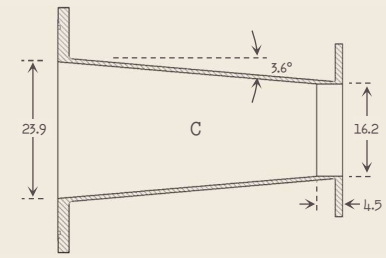
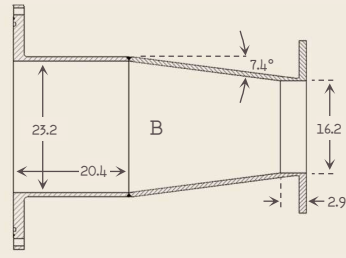
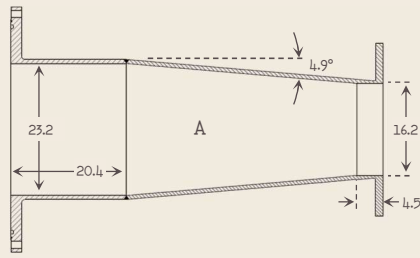
| Nozzle | Contour | L_{CC} | D_{NT} | $\frac{A_{CC}}{A_{NT}}$ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | No. of Tests | Mean c^*/c_{CEA}^* |
|--------|---------|----------|----------|-------------------------|-------------------------|---------------|--------------|----------------------|
| | | | | [cm] | [cm] | | | |
| Conv. | TOP | 27.2 | 231 | 6.1 | 76.7 | 19 | 205 | 0.98 |
| DMLS | TOP | 7.29 | 234 | 6.0 | 76.4 | 19 | 5 | 0.94 |

Table 1.1 Nozzle geometry and performance characteristics.

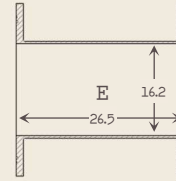
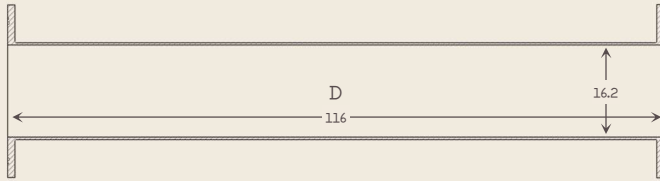
| Copper Liner | | | | Steel Extension | | | |
|--------------|-------|-------|-------|-----------------|-------|-------|-------|
| x | r | x | r | x | r | x | r |
| 0.000 | 1.156 | 0.826 | 1.683 | 3.750 | 3.788 | 10.75 | 7.474 |
| 0.012 | 1.156 | 0.935 | 1.763 | 3.969 | 3.927 | 10.97 | 7.570 |
| 0.025 | 1.157 | 1.045 | 1.844 | 4.188 | 4.064 | 11.19 | 7.665 |
| 0.038 | 1.159 | 1.154 | 1.925 | 4.407 | 4.199 | 11.41 | 7.760 |
| 0.051 | 1.162 | 1.263 | 2.005 | 4.626 | 4.332 | 11.63 | 7.854 |
| 0.063 | 1.165 | 1.373 | 2.086 | 4.845 | 4.464 | 11.85 | 7.947 |
| 0.076 | 1.169 | 1.482 | 2.166 | 5.063 | 4.593 | 12.07 | 8.039 |
| 0.088 | 1.173 | 1.592 | 2.246 | 5.282 | 4.721 | 12.28 | 8.130 |
| 0.100 | 1.179 | 1.701 | 2.326 | 5.501 | 4.847 | 12.50 | 8.221 |
| 0.111 | 1.185 | 1.811 | 2.405 | 5.720 | 4.971 | 12.72 | 8.311 |
| 0.123 | 1.191 | 1.920 | 2.484 | 5.939 | 5.094 | 12.94 | 8.400 |
| 0.133 | 1.198 | 2.029 | 2.562 | 6.157 | 5.215 | 13.16 | 8.488 |
| 0.143 | 1.204 | 2.139 | 2.640 | 6.376 | 5.335 | 13.38 | 8.576 |
| 0.154 | 1.211 | 2.248 | 2.718 | 6.595 | 5.453 | 13.60 | 8.662 |
| 0.162 | 1.217 | 2.358 | 2.795 | 6.814 | 5.570 | 13.82 | 8.749 |
| 0.173 | 1.224 | 2.467 | 2.872 | 7.033 | 5.686 | 14.03 | 8.834 |
| 0.186 | 1.232 | 2.576 | 2.948 | 7.252 | 5.800 | 14.25 | 8.919 |
| 0.202 | 1.242 | 2.686 | 3.024 | 7.470 | 5.913 | 14.47 | 9.003 |
| 0.220 | 1.255 | 2.795 | 3.099 | 7.689 | 6.025 | 14.69 | 9.086 |
| 0.243 | 1.270 | 2.905 | 3.173 | 7.908 | 6.135 | 14.91 | 9.169 |
| 0.271 | 1.289 | 3.014 | 3.248 | 8.127 | 6.245 | 15.13 | 9.251 |
| 0.304 | 1.312 | 3.123 | 3.321 | 8.346 | 6.353 | 15.35 | 9.333 |
| 0.345 | 1.340 | 3.233 | 3.395 | 8.564 | 6.460 | 15.57 | 9.414 |
| 0.394 | 1.373 | 3.342 | 3.467 | 8.783 | 6.566 | 15.78 | 9.495 |
| 0.453 | 1.415 | 3.452 | 3.539 | 9.002 | 6.671 | 16.00 | 9.574 |
| 0.525 | 1.466 | 3.561 | 3.611 | 9.221 | 6.774 | 16.22 | 9.654 |
| 0.612 | 1.528 | 3.670 | 3.682 | 9.440 | 6.877 | 16.44 | 9.733 |
| 0.716 | 1.603 | 3.750 | 3.734 | 9.658 | 6.979 | 16.66 | 9.811 |
| | | | | 9.877 | 7.080 | 16.88 | 9.888 |
| | | | | 10.10 | 7.180 | 17.10 | 9.965 |
| | | | | 10.31 | 7.279 | 17.32 | 10.04 |
| | | | | 10.53 | 7.377 | 17.54 | 10.12 |

Table 1.2 Conventionally-machined nozzle profile, dimensions given in cm.

Inlets



Throats



Subsonic Diffuser

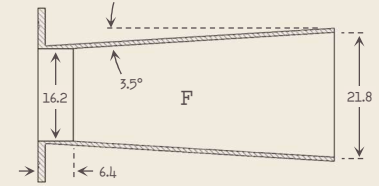


Figure 2. Cross-sections of second-throat diffuser components. Linear dimensions given in cm.

| Diffuser Assembly | $\frac{A_{DI}}{A_{NT}}$ | θ_{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{L_D}{D_{DI}}$ | No. of Tests | Avg. O:F | M_{DI} | $\frac{P_{CC}}{P_{BACK}}$ | $\left(\frac{P_{CELL}}{P_{CC}}\right) \times 10^5$ | |
|-------------------|-------------------------|---------------|-------------------------|-------------------------|-------------------------|----------------------|----------------------|--------------|----------|----------|---------------------------|--|------|
| | [deg] | | | | | | | | | | Start Unst. | | |
| A | 100.7 | 4.9 | 0.49 | 0.64 | - | 4.1 | 2.0 | 4 | 5.9 | 4.78 | 62.5 | 59.4 | 75.4 |
| AF | 100.7 | 4.9 | 0.49 | 0.64 | 1.82 | 7.3 | 3.6 | 4 | 6.0 | 4.76 | 55.4 | 52.4 | 80.1 |
| AEF | 100.7 | 4.9 | 0.49 | 0.64 | 1.82 | 8.9 | 4.4 | 4 | 6.1 | 4.73 | 50.7 | 46.9 | 81.9 |
| AD | 100.7 | 4.9 | 0.49 | 0.64 | - | 11.2 | 5.5 | 4 | 6.0 | 4.76 | 60.7 | 39.3 | 80.5 |
| ADF | 100.7 | 4.9 | 0.49 | 0.64 | 1.82 | 14.5 | 7.1 | 19 | 6.1 | 4.73 | 51.7 | 36.3 | 89.0 |
| B | 100.7 | 7.4 | 0.49 | 0.64 | - | 3.1 | 1.5 | 3 | 5.7 | 4.84 | 63.7 | 63.3 | 69.2 |
| BF | 100.7 | 7.4 | 0.49 | 0.64 | 1.82 | 6.3 | 3.1 | 6 | 6.1 | 4.73 | 60.0 | 56.3 | 71.5 |
| BEF | 100.7 | 7.4 | 0.49 | 0.64 | 1.82 | 8.0 | 3.9 | 5 | 6.0 | 4.76 | 48.6 | 45.6 | 76.8 |
| BD | 100.7 | 7.4 | 0.49 | 0.64 | - | 10.3 | 5.0 | 6 | 6.1 | 4.73 | 55.4 | 42.7 | 72.7 |
| BDF | 100.7 | 7.4 | 0.49 | 0.64 | 1.82 | 13.5 | 6.6 | 14 | 6.0 | 4.76 | 48.6 | 37.6 | 93.2 |
| C | 106.9 | 3.6 | 0.46 | 0.64 | - | 3.1 | 1.4 | 4 | 6.0 | 4.80 | 62.9 | 62.9 | 88.8 |
| CE | 106.9 | 3.6 | 0.46 | 0.64 | - | 4.8 | 2.2 | 5 | 5.9 | 4.83 | - | - | - |
| CF | 106.9 | 3.6 | 0.46 | 0.64 | 1.82 | 6.3 | 2.9 | 10 | 6.0 | 4.80 | 56.1 | 51.0 | 93.5 |
| CEF | 106.9 | 3.6 | 0.46 | 0.64 | 1.82 | 8.0 | 3.7 | 9 | 6.0 | 4.80 | 45.6 | 42.2 | 97.9 |
| CD | 106.9 | 3.6 | 0.46 | 0.64 | - | 10.3 | 4.7 | 5 | 6.1 | 4.77 | 53 | 38.9 | 109 |
| CDF | 106.9 | 3.6 | 0.46 | 0.64 | 1.82 | 13.5 | 6.2 | 26 | 6.0 | 4.80 | 46.3 | 35.4 | 108 |

Table 2. Summary of second-throat diffuser assembly geometric and performance characteristics.

□ Absolute start: Occurs at the minimum P_{CC}/P_{BACK} which stably isolates the test cell from downstream conditions if the inflow conditions are held constant.

○ Approximate start: Occurs at the P_{CC}/P_{BACK} obtained by extrapolation of the initial evacuation slope to the steady-state P_{CELL}/P_{CC} line. Often conservative, but useful when absolute start is indeterminate due to insufficient data resolution or a physical lag in test cell evacuation relative to supersonic plume development.

Approximations will converge to the absolute start curve if any of the following are achieved:

- 1) dP_{CC}/dt is low enough to keep dP_{CELL}/dt near zero prior to start.
- 2) P_{CC}/P_{BACK} does not overshoot the required starting point.
- 3) Test cell volume is small and evacuation is nearly instantaneous.

▲ Unstart: Occurs at the P_{CC}/P_{BACK} below which the test cell is affected by downstream conditions. Onset is independent of dP_{CC}/dt , though the slope of the subsequent recompression will vary with dP_{CC}/dt and test cell volume.

× Non-start: occurs when the diffuser fails to start, either due to insufficient pressure ratio or insufficient second-throat area.

Operation with insufficient pressure ratio will produce a pumpdown curve nearly identical to that of a starting diffuser, except that it reverses prior to test cell evacuation. A distinct curve may be produced as the driving pressure is reduced, caused by a hysteresis effect in the boundary layer separation within the nozzle.

Operation with insufficient second-throat area will also produce a pumpdown curve initially similar to that of a starting diffuser. However, once the plume begins to expand beyond the nozzle, the diffuser cannot "swallow the shocks" and the flow will lock into a structure characterized by annular shock reflections extending from the nozzle exit to the diffuser inlet. P_{CELL} remains elevated near impingement levels as P_{CC} increases.

◇ Pseudo-start: oscillatory start/unstart behavior that occurs when a diffuser is operating with sufficient P_{CC}/P_{BACK} to force the plume boundary to the diffuser inlet, but insufficient recompression in the throat to keep attachment stable. Absolute start can still be achieved by increasing P_{CC}/P_{BACK} .

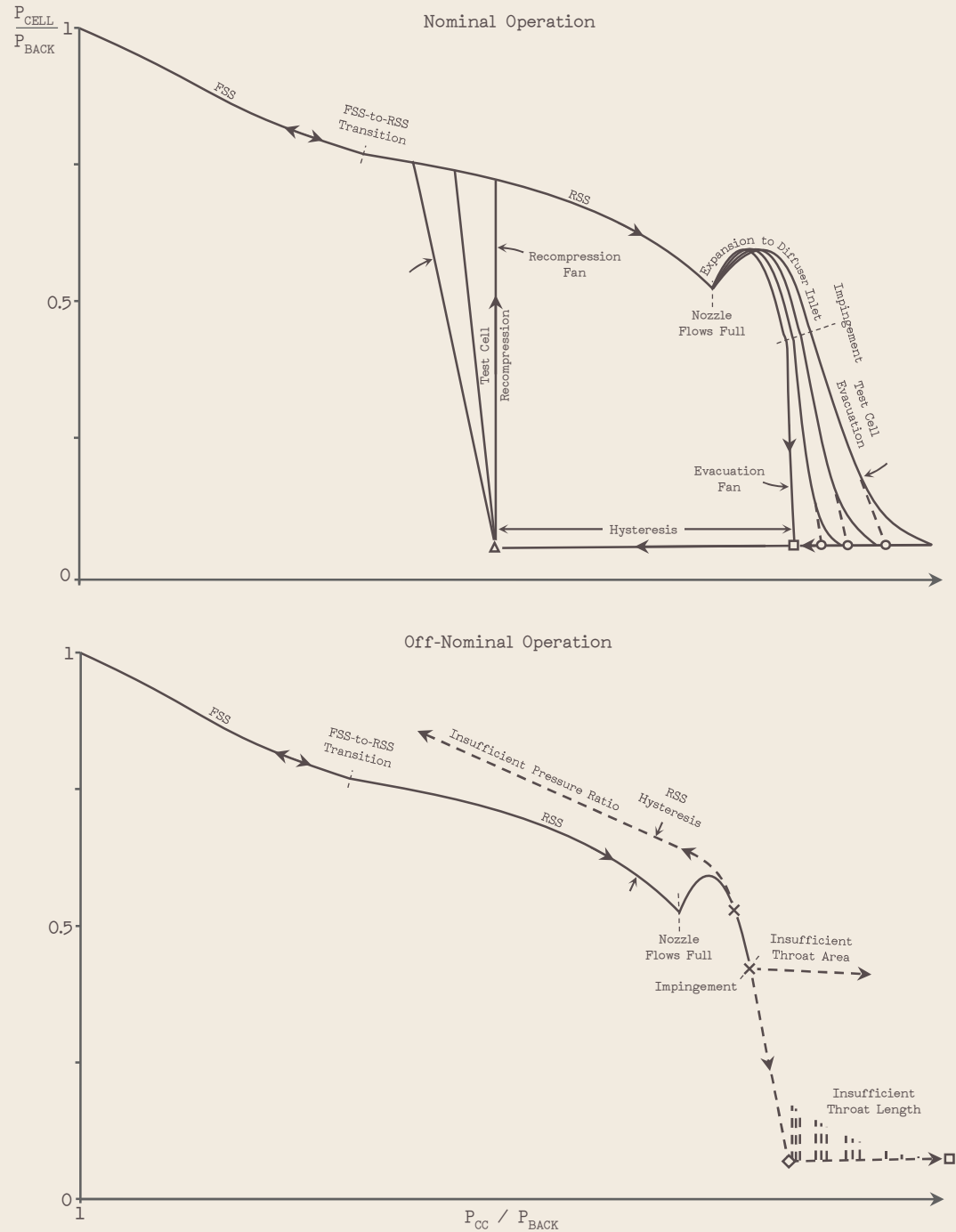


Figure 3. Idealized nominal and off-nominal diffuser pumpdown curves showing plume behavior at varying P_{CC} ramp rates.

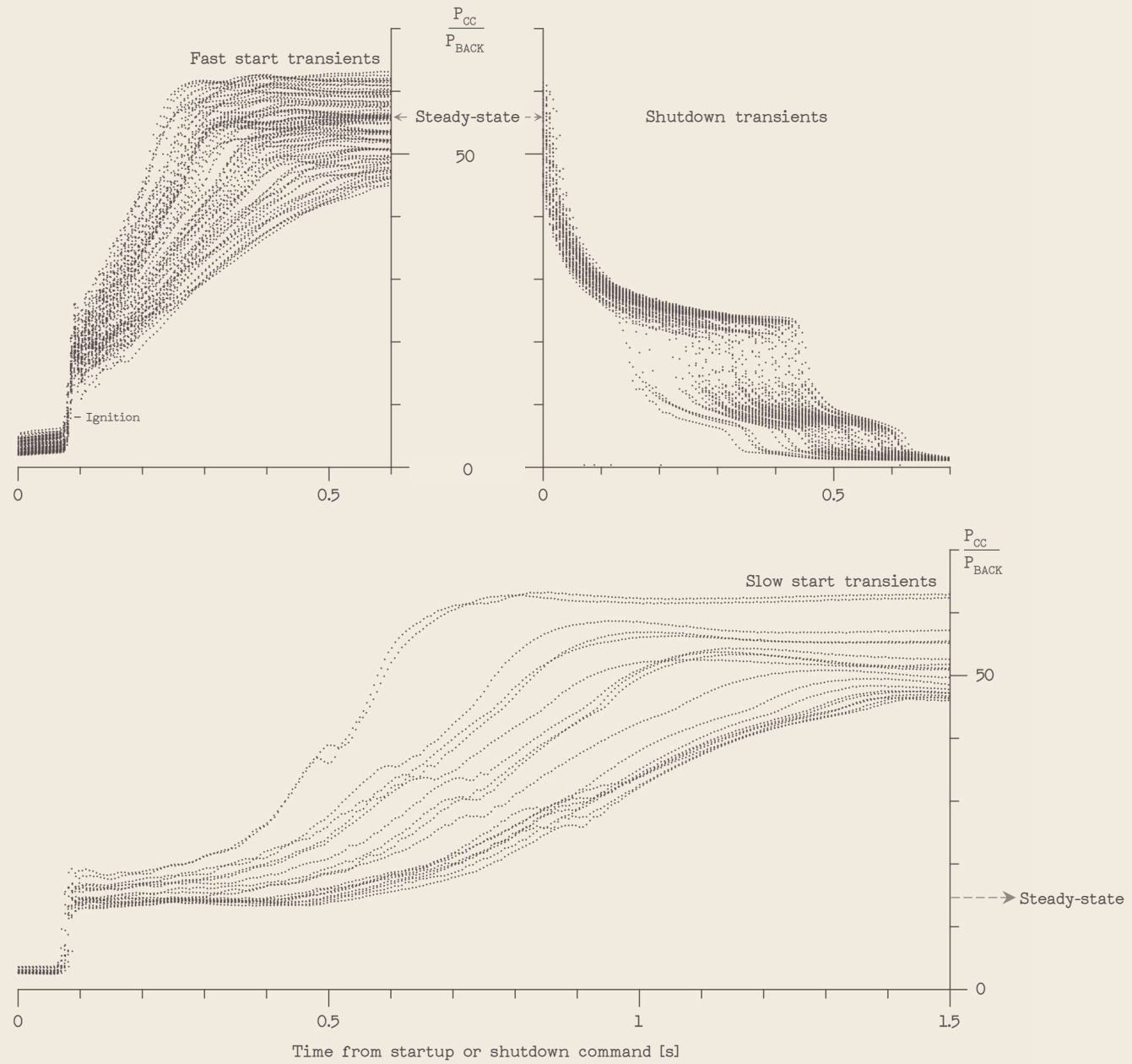


Figure 4. Typical thruster transients.

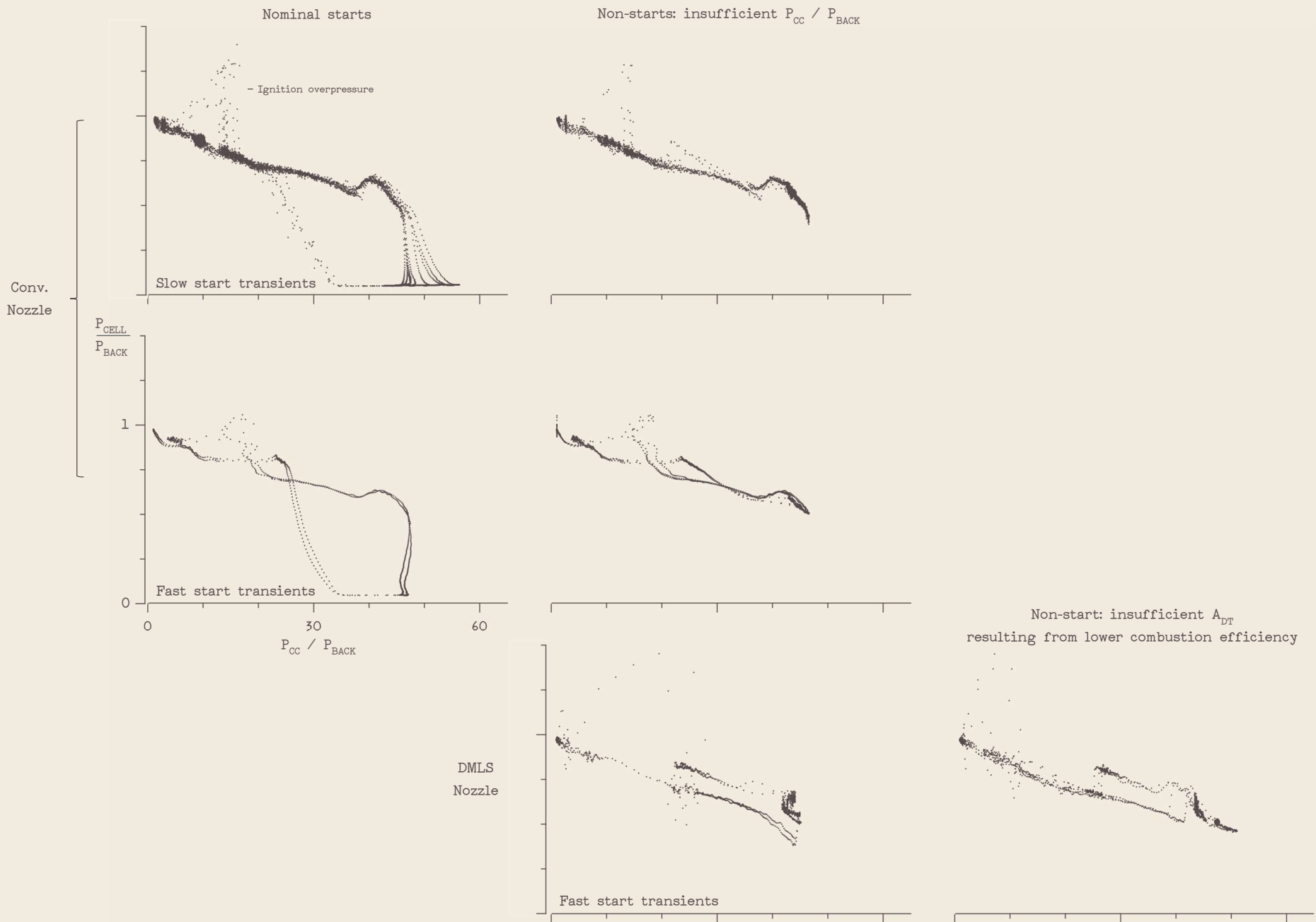


Figure 5. Pumpdown curves, CDF configuration operating with both nozzles and differing P_{CC} transients.

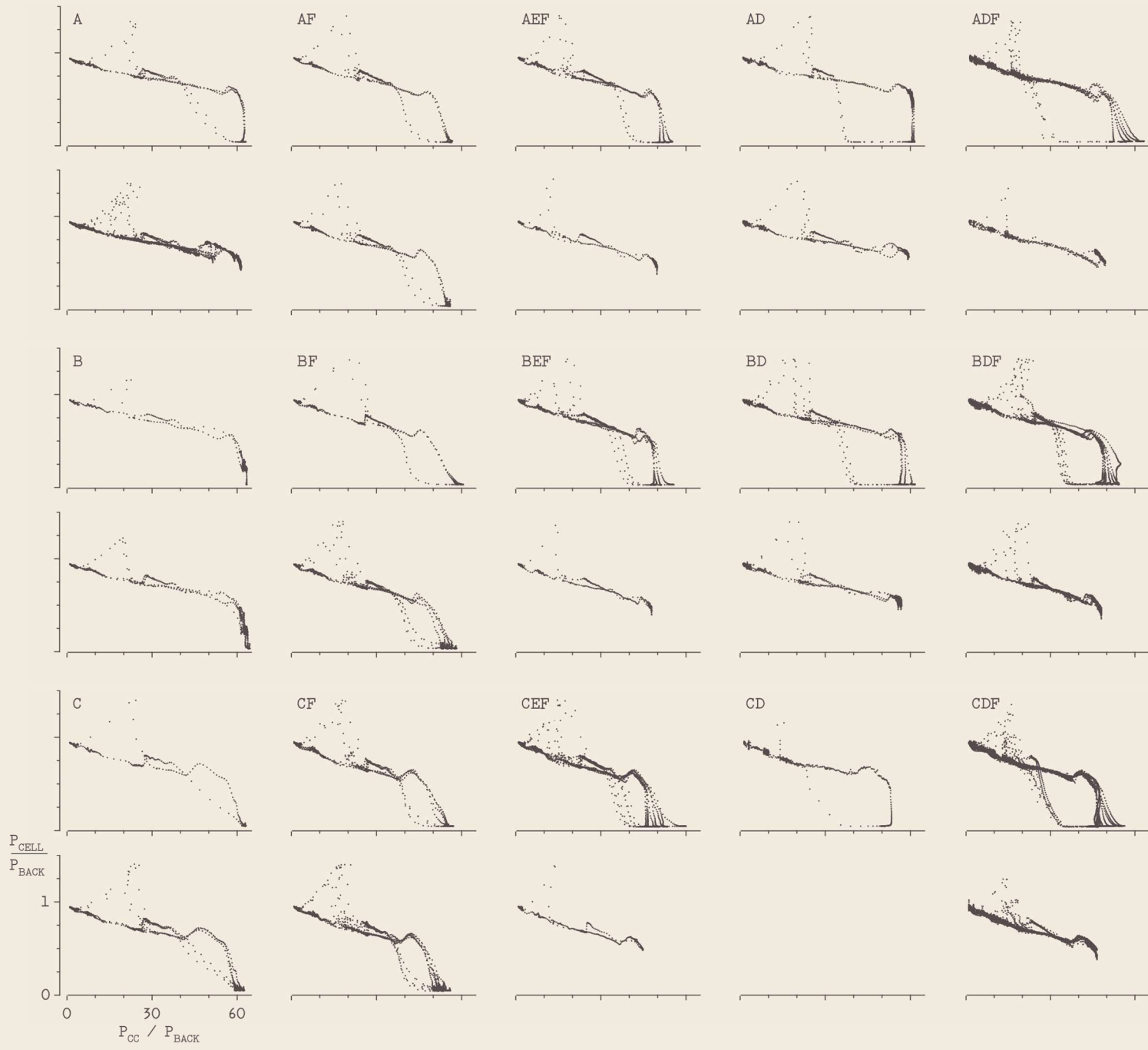


Figure 6. Pumpdown curves, nominal (top) and off-nominal (bottom) behavior of second-throat configurations which achieved absolute start.

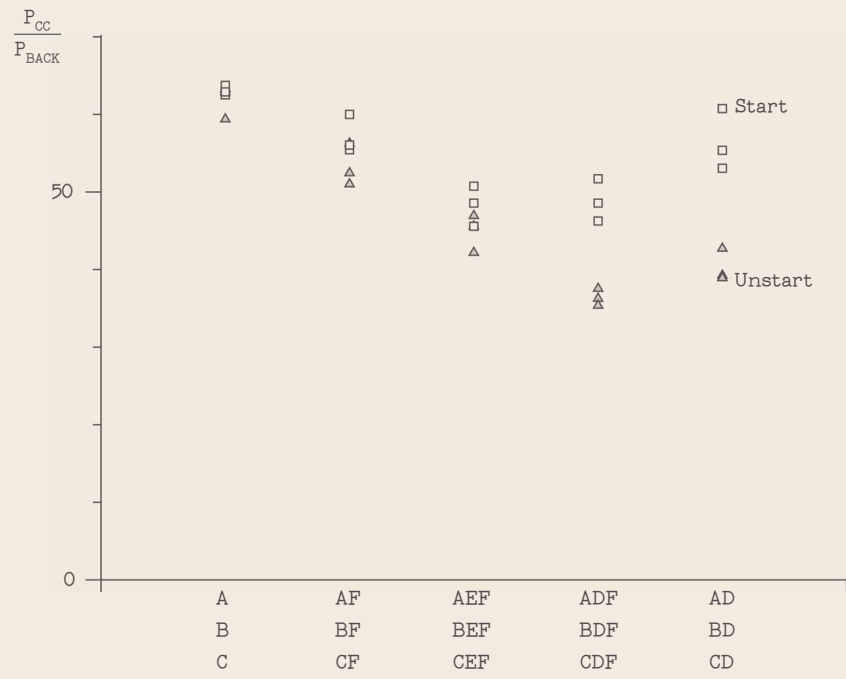


Figure 7. Second-throat start and unstart pressure ratios grouped by assembly type.

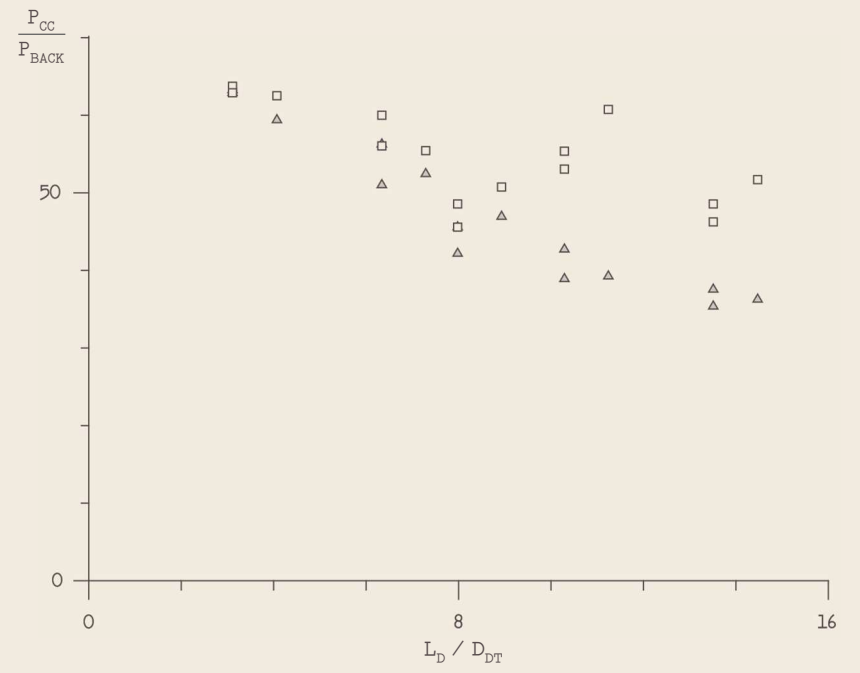


Figure 8. Sensitivity of start and unstart performance to diffuser length.

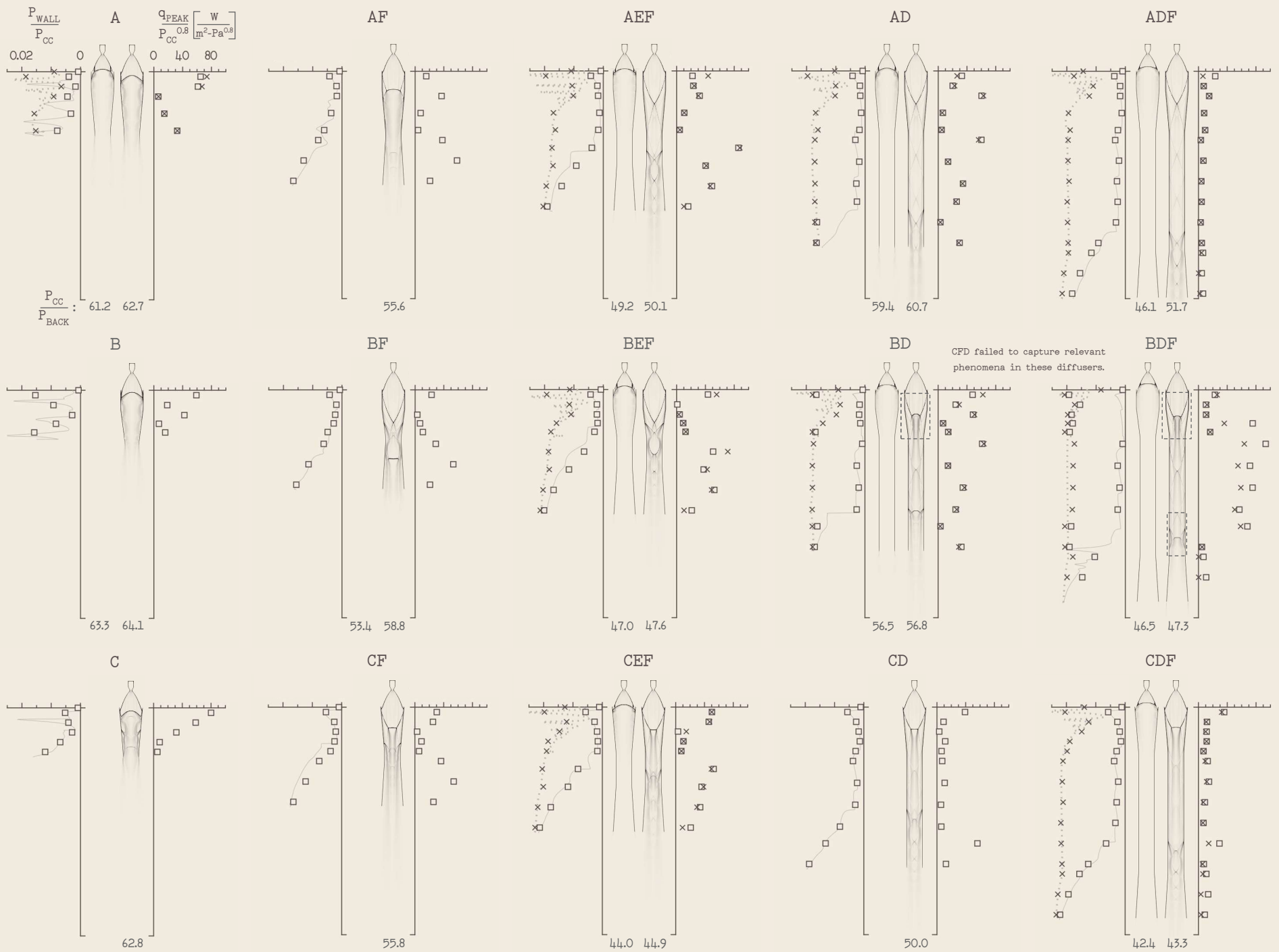


Figure 9. Spatial representations of flow characteristics for second-throat diffusers during nominal and off-nominal runs. Left: Experimental (markers) and CFD (lines) steady-state wall pressures. Center: Corresponding CFD-produced shock structures. Right: Experimental P_{CC} -normalized peak 0.1-second heat flux densities.



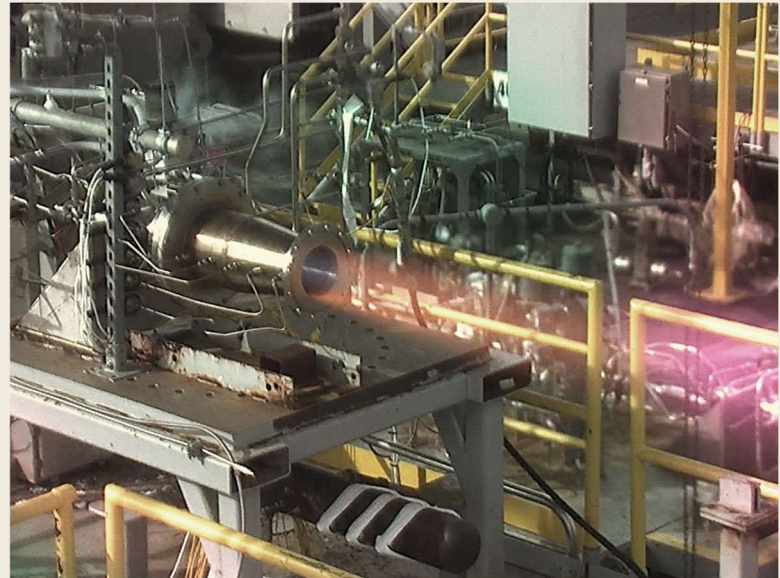
DMLS and conventionally-machined rocket liners.



Diffuser segments.



Configuration ADF on the stand.



Configuration B during steady-state operation.

Figure 10. Photos of rocket and second-throat diffuser hardware.

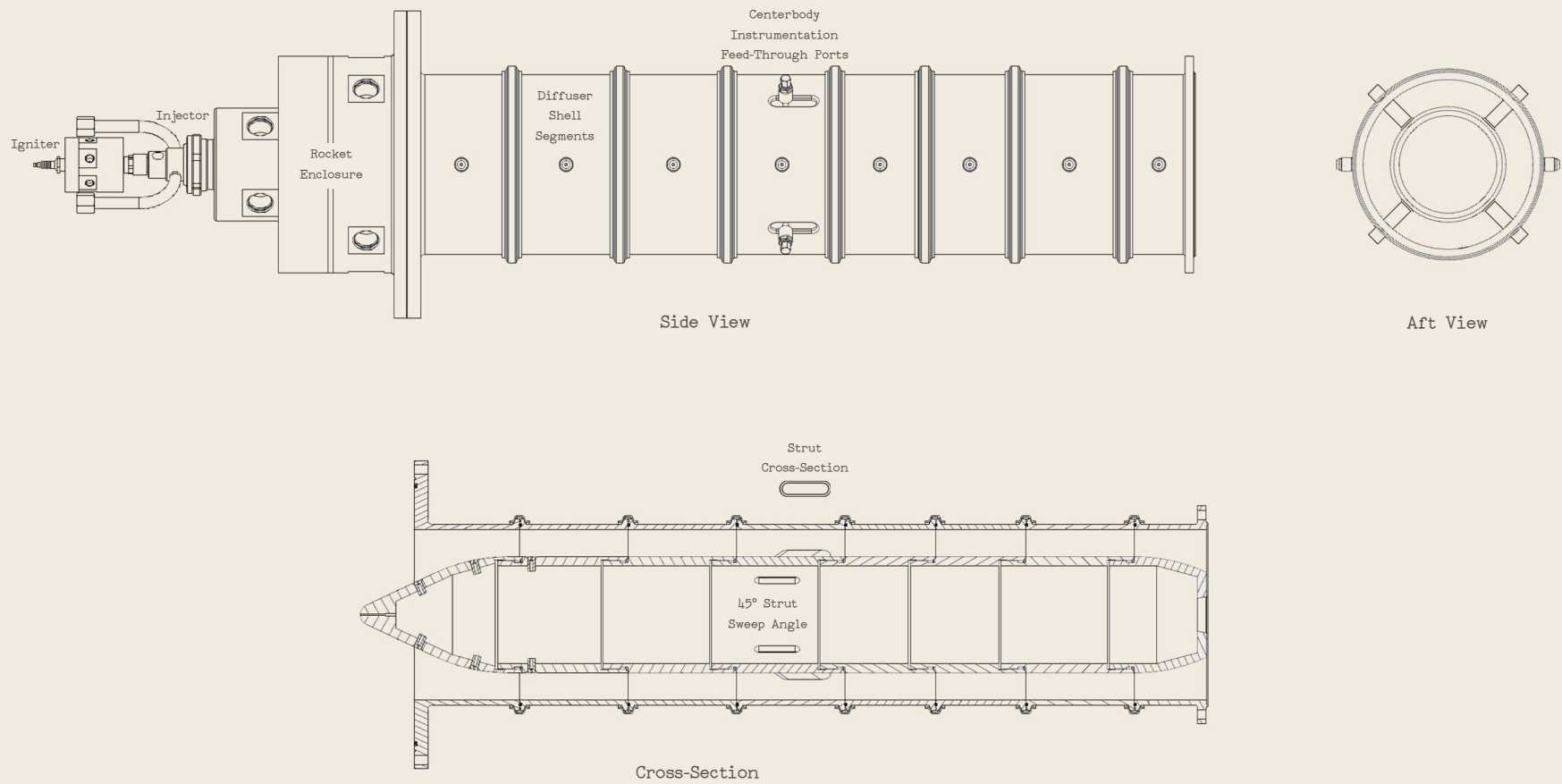


Figure 11. CB-1 hardware configuration.

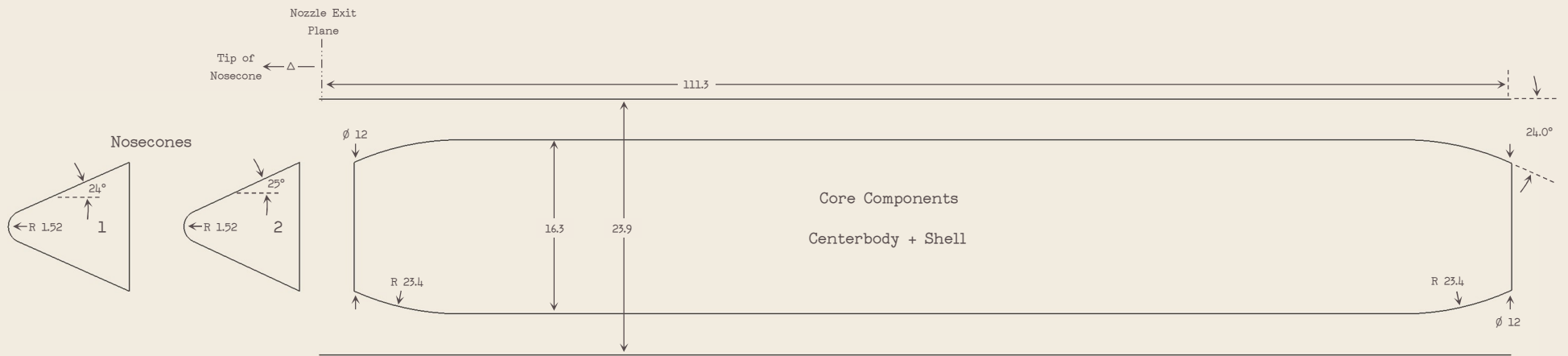


Figure 12. Aerodynamic contours of centerbody diffuser components. Linear dimensions given in cm.

| Contour | $\frac{\Delta}{R_{NE}}$ | $\frac{R_{TTP}}{R_{NE}}$ | θ_{TTP} [deg] | $\frac{A_{DI}}{A_{NT}}$ | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{L_{SHL}}{D_{DI}}$ | No. of Tests | Avg. O:F | M_{DI} | $\frac{P_{CC}}{P_{BACK}}$ | | $\left(\frac{P_{CELL}}{P_{CC}}\right) \times 10^5$ |
|---------|-------------------------|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|-----------------|-------------|----------|---------------------------|-------|--|
| | | | | | | | | | | | Start | Unst. | |
| CB-1 | 0.79 | 0.15 | 24 | 106.9 | 0.54 | 0.74 | 4.66 | 8 | 6.0 | 4.81 | 4.08 | 4.08 | 95.7 |
| CB-2 | 0.75 | 0.15 | 25 | 106.9 | 0.54 | 0.74 | 4.66 | 12 | 6.2 | 4.75 | 4.12 | 4.05 | 106 |

Table 3. Summary of centerbody diffuser geometric and performance characteristics.

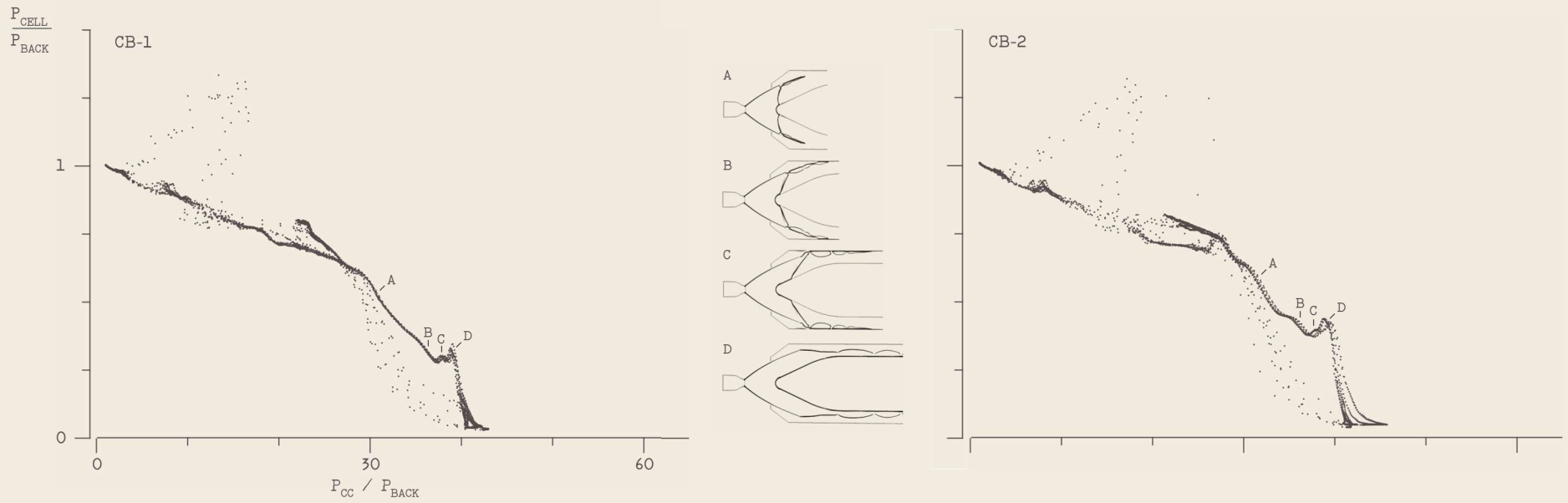


Figure 13. Centerbody diffuser pumpdown curves with annotated details of plume development around the nosecone. CFD illustrations used CB-2 geometry.

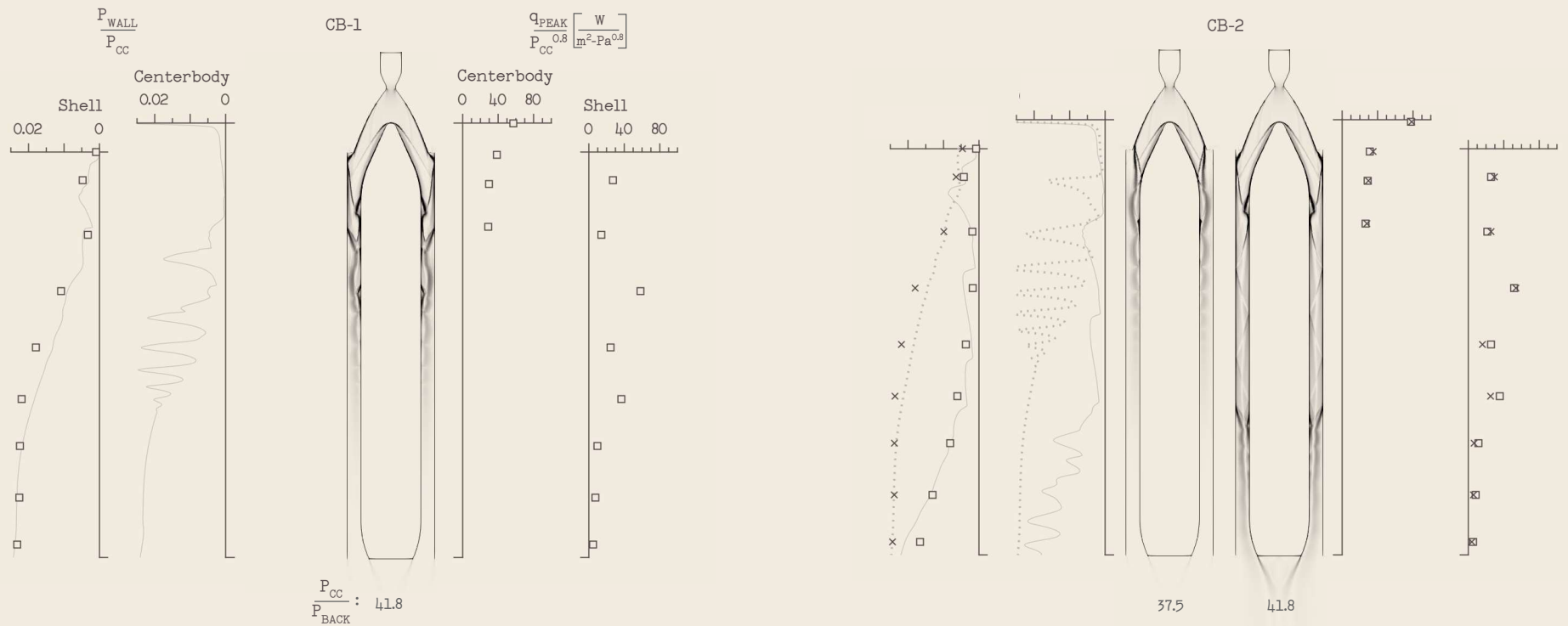
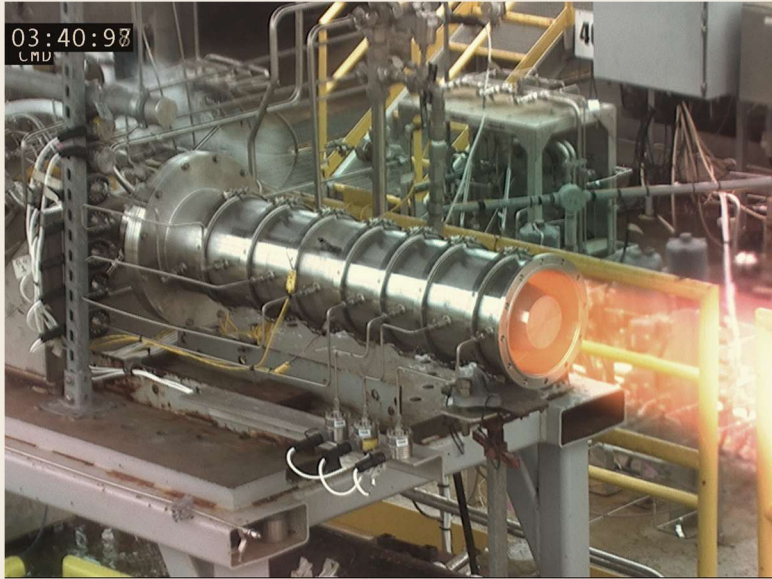
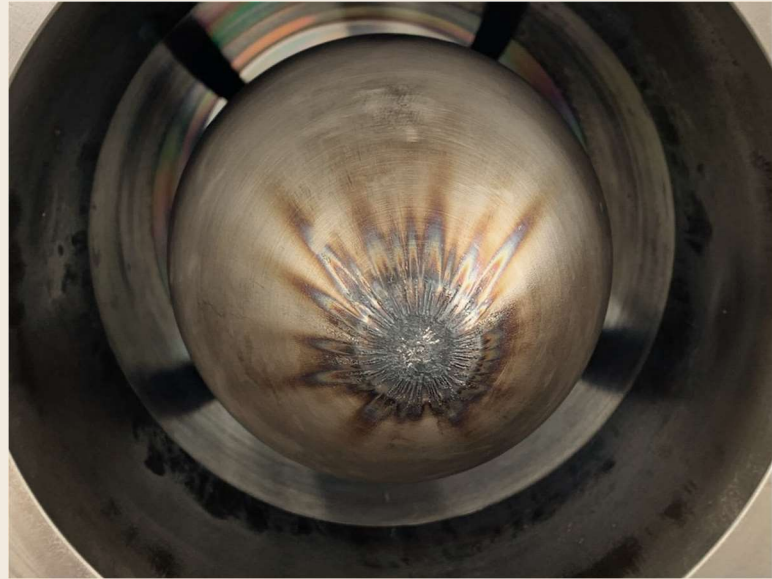


Figure 14. Spatial representations of flow characteristics for centerbody diffusers during nominal and off-nominal runs. Left: Experimental (markers) and CFD (lines) steady-state wall pressures. Center: Corresponding CFD-produced shock structures. Right: Experimental P_{CC} -normalized peak 0.1-second heat flux densities.



Steady-state operation.



Front view of nosecone 1 erosion after 11.4 seconds of firing.

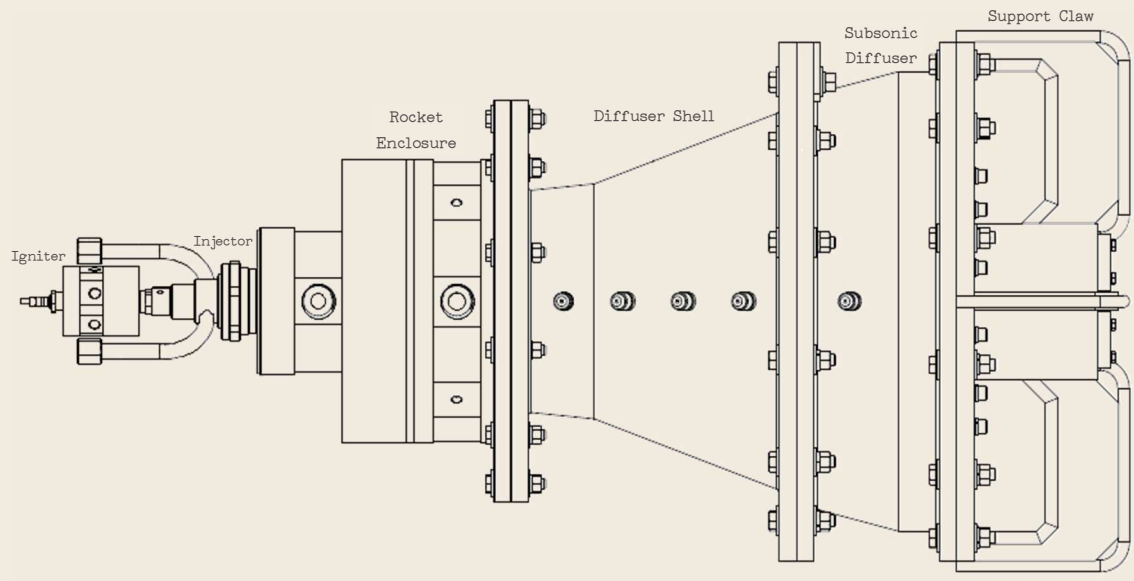


Inspection of nosecone 2 erosion after 14 seconds of firing.

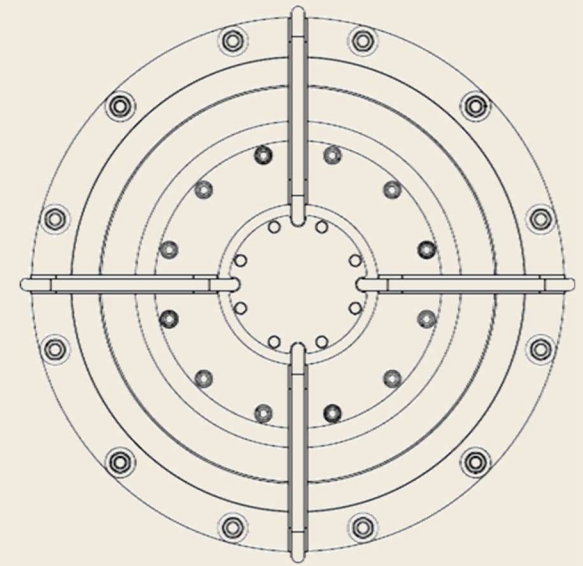


Side view of nosecone 1 erosion after 11.4 seconds of firing.

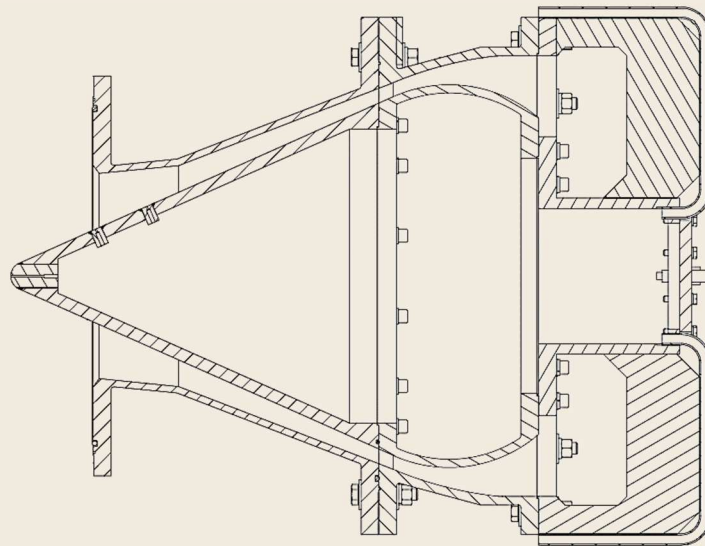
Figure 15. Photos of centerbody diffuser hardware.



Side View



Aft View



Diffuser Cross-Section

Figure 16. SPK-3X hardware configuration.

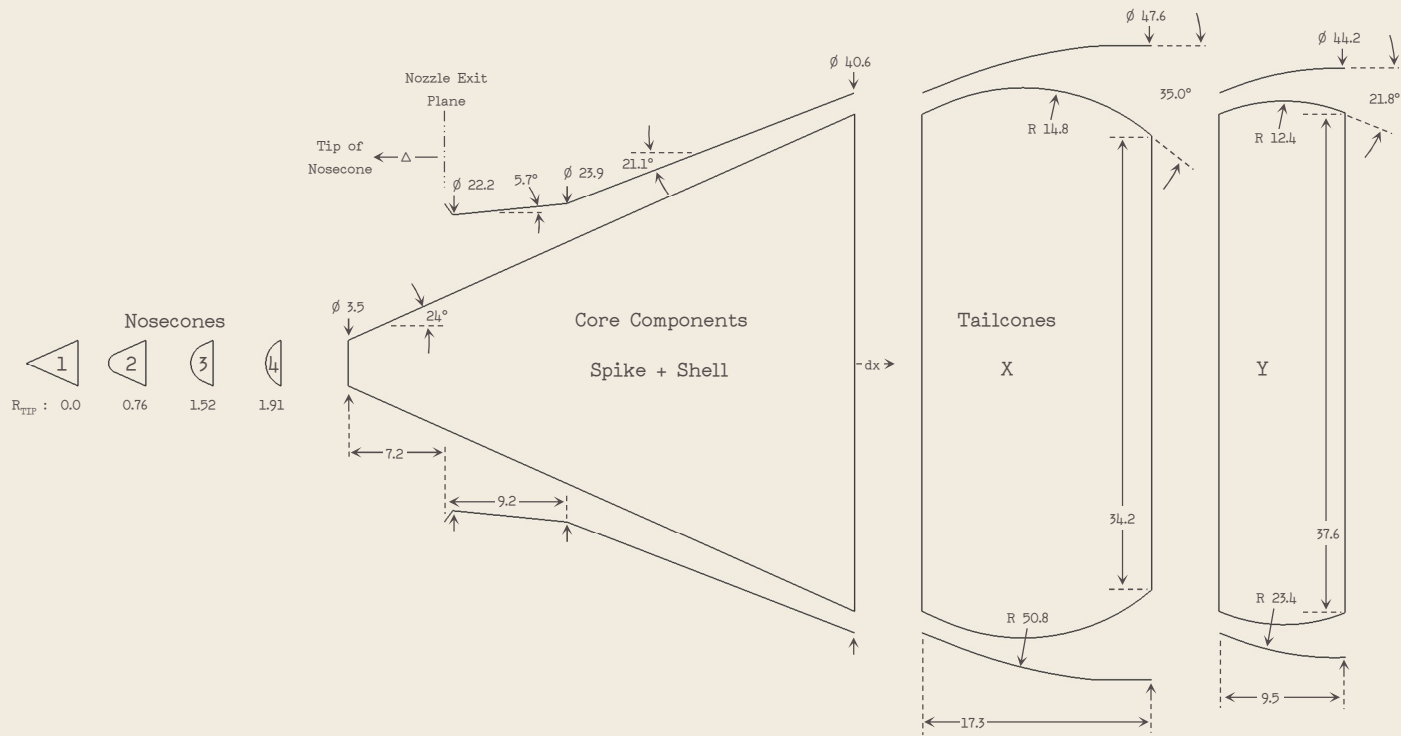


Figure 17. Aerodynamic contours of spike diffuser components. Linear dimensions given in cm.

| Contour | $\frac{dx}{R_{NE}}$ | $\frac{\Delta}{R_{NE}}$ | $\frac{R_{TIP}}{R_{NE}}$ | θ_{TIP} | $\frac{A_{DI}}{A_{NT}}$ | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{L_{SHL}}{D_{DI}}$ | No. of Tests | Avg. O:F | M_{DI} | $\frac{P_{CC}}{P_{BACK}} \left(\frac{P_{CELL}}{P_{CC}} \right) \times 10^5$ | | |
|---------|---------------------|-------------------------|--------------------------|----------------|-------------------------|-------------------------|-------------------------|--------------------------|--------------|----------|----------|--|-------|-------|
| | | | | | | | | | | | | Start | Unst. | |
| SPK-1X | -0.014 | 1.11 | 0.00 | 24 | 106.9 | 0.39 | 0.54 | 2.0 | 7 | 6.1 | 4.74 | 34.6 | 323 | 104.1 |
| SPK-2X | -0.014 | 1.00 | 0.08 | 24 | 106.9 | 0.39 | 0.54 | 2.0 | 5 | 6.1 | 4.76 | 34.9 | 327 | 101.1 |
| SPK-3X | -0.014 | 0.89 | 0.15 | 24 | 106.9 | 0.39 | 0.54 | 2.0 | 5 | 6.1 | 4.76 | 35.2 | 33.1 | 101.9 |
| | 0 | 0.88 | 0.15 | 24 | 106.9 | 0.40 | 0.55 | 2.0 | 9 | 6.1 | 4.76 | 35.7 | 33.7 | 110.5 |
| SPK-4X | -0.029 | 0.85 | 0.19 | 24 | 106.9 | 0.38 | 0.53 | 2.0 | 2 | 5.8 | 4.85 | - | - | - |
| | -0.014 | 0.84 | 0.19 | 24 | 106.9 | 0.39 | 0.54 | 2.0 | 9 | 6.0 | 4.79 | 35.3 | 34.0 | 113.2 |
| | 0 | 0.82 | 0.19 | 24 | 106.9 | 0.40 | 0.55 | 2.0 | 8 | 6.1 | 4.76 | 36.3 | 34.7 | 106.8 |
| | 0.057 | 0.82 | 0.19 | 24 | 106.9 | 0.43 | 0.59 | 2.0 | 6 | 5.6 | 4.91 | 37.8 | 35.9 | 116.0 |
| SPK-3Y | -0.014 | 0.89 | 0.15 | 24 | 106.9 | 0.39 | 0.54 | 1.7 | 5 | 6.0 | 4.79 | 36.2 | 34.7 | 98.2 |
| SPK-4Y | -0.014 | 0.84 | 0.19 | 24 | 106.9 | 0.39 | 0.54 | 1.7 | 10 | 6.1 | 4.76 | 35.0 | 34.9 | 89.9 |

Table 4. Summary of spike diffuser geometric and performance characteristics.

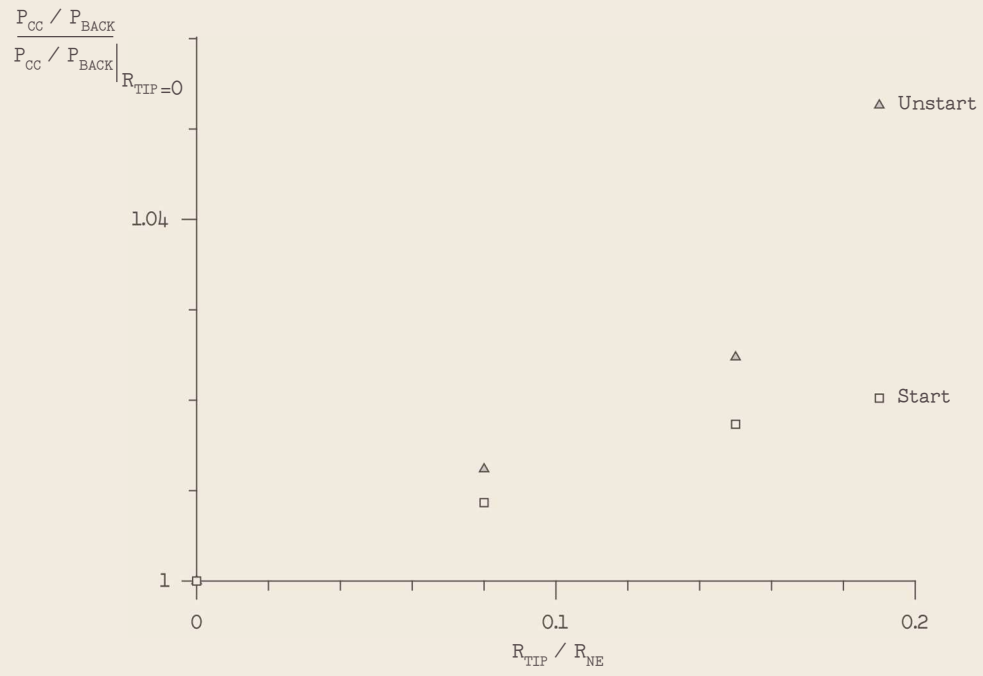


Figure 18. Sensitivity of spike performance to tip radius. Tailcone X installed.

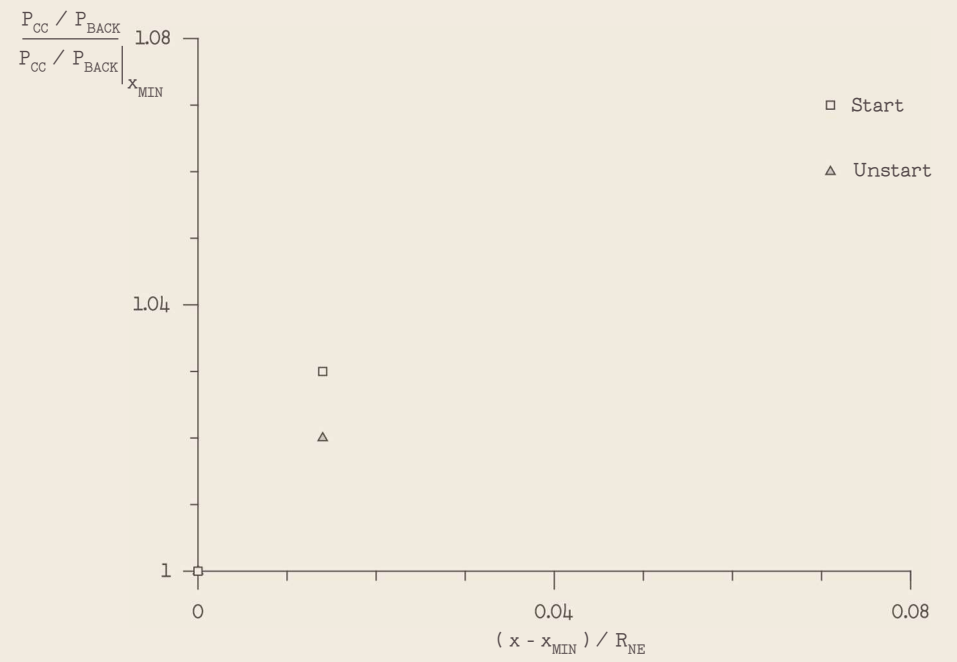


Figure 19. Sensitivity of SPK-4X to spike position.

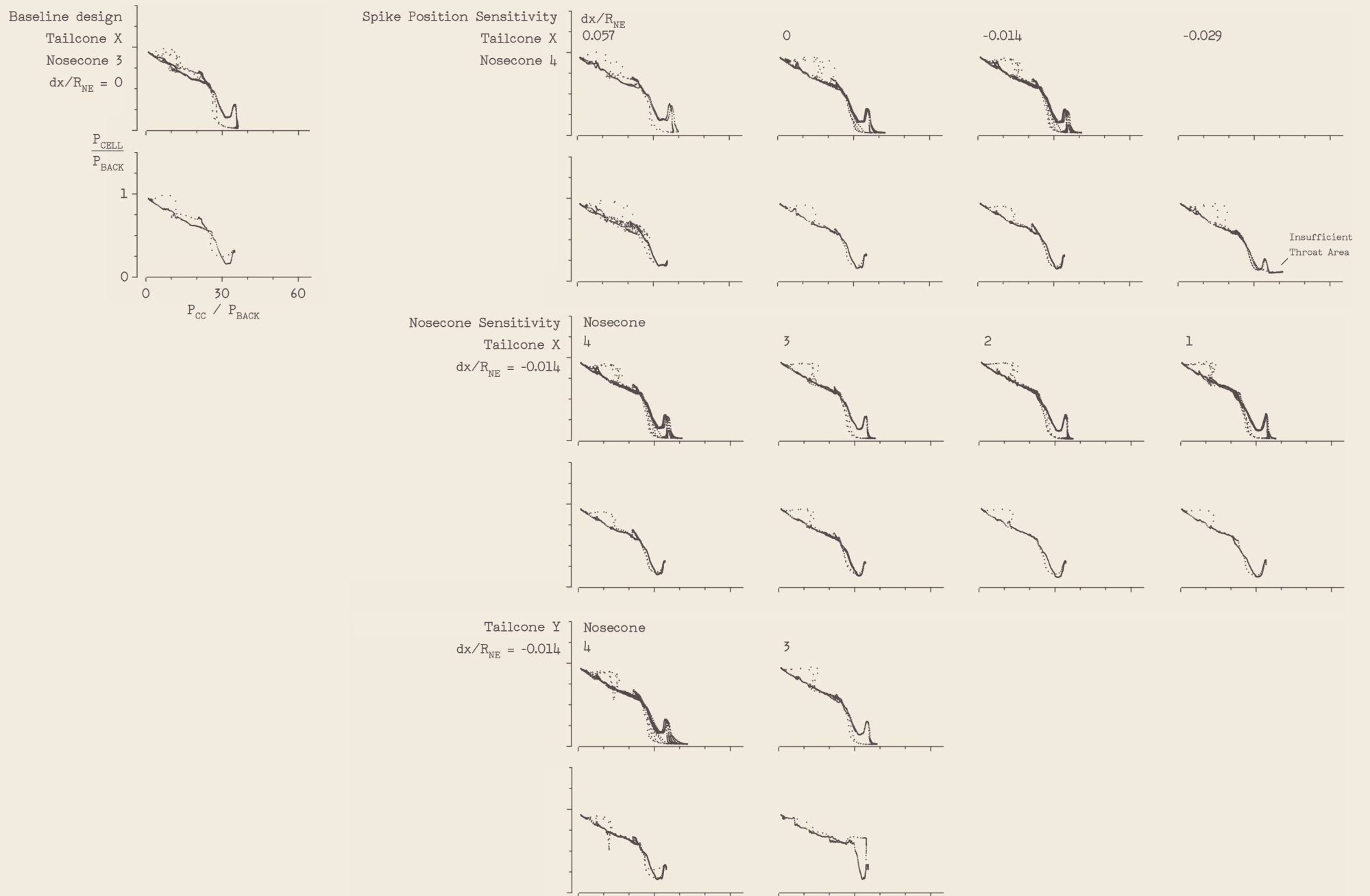


Figure 20. Nominal (top) and off-nominal (bottom) pumpdown curves for all spike configurations.

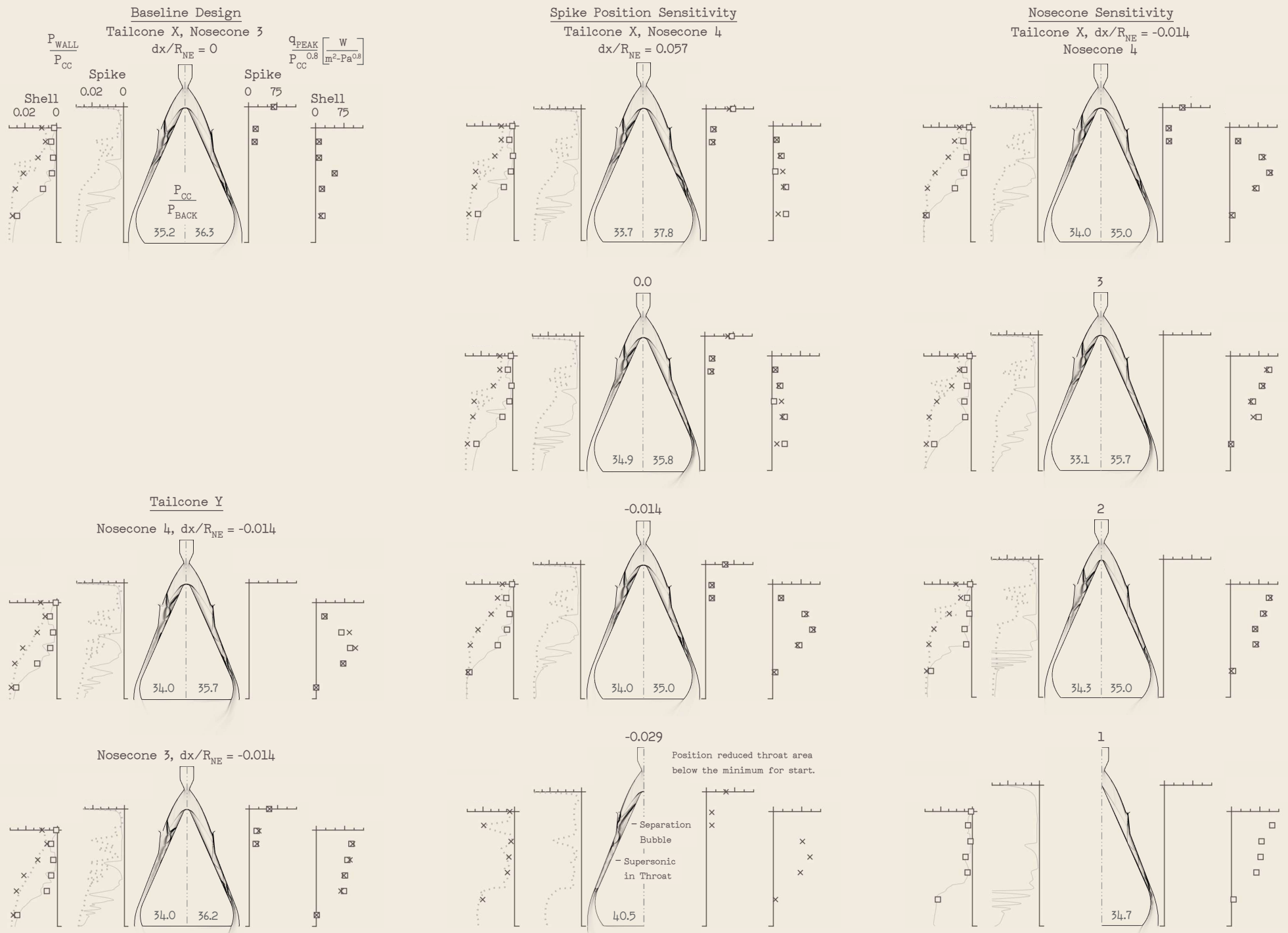
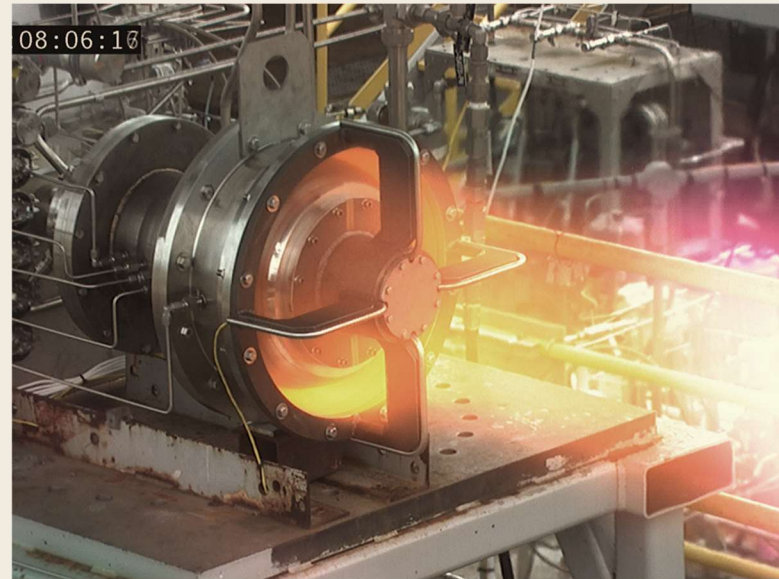


Figure 21. Spatial representations of flow characteristics for spike diffusers during nominal and off-nominal runs. Left: Experimental (markers) and CFD (lines) steady-state wall pressures. Center: Corresponding CFD-produced shock structures. Right: Experimental P_{CC} -normalized peak 0.1-second heat flux densities.



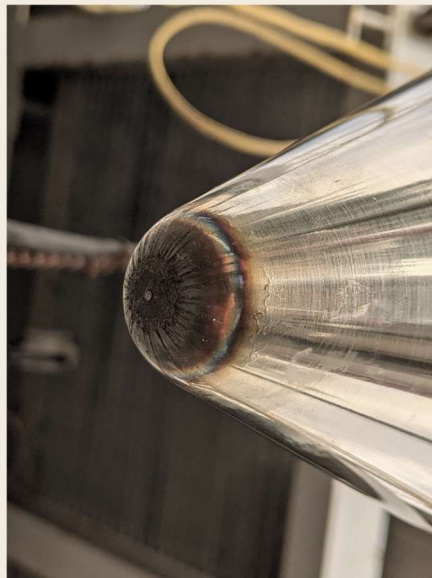
Side view during installation.



Steady-state operation.



Shell-wall boundary layer separation line revealed by external condensation.



Erosion of nosecone 3 after 13.7 seconds of firing.



Discolored bands indicate separation and reattachment points on spike wall.

Figure 22. Photos of spike diffuser hardware.



Figure 23. Pumpdown performance comparison: best-starting diffusers of each topology.

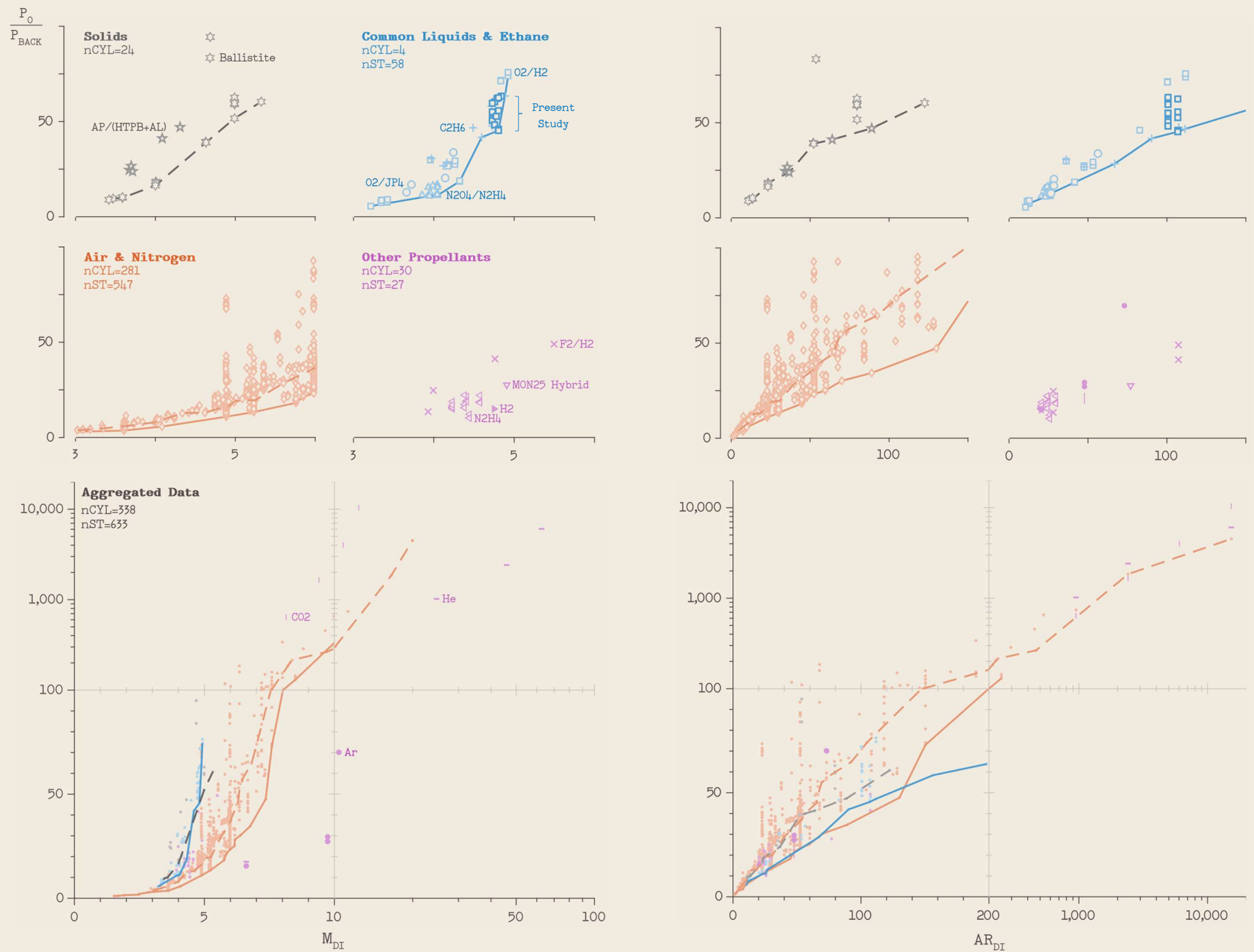


Figure 24. Empirical frontiers of cylindrical (dashed) and second-throat (solid) diffuser starting performance.

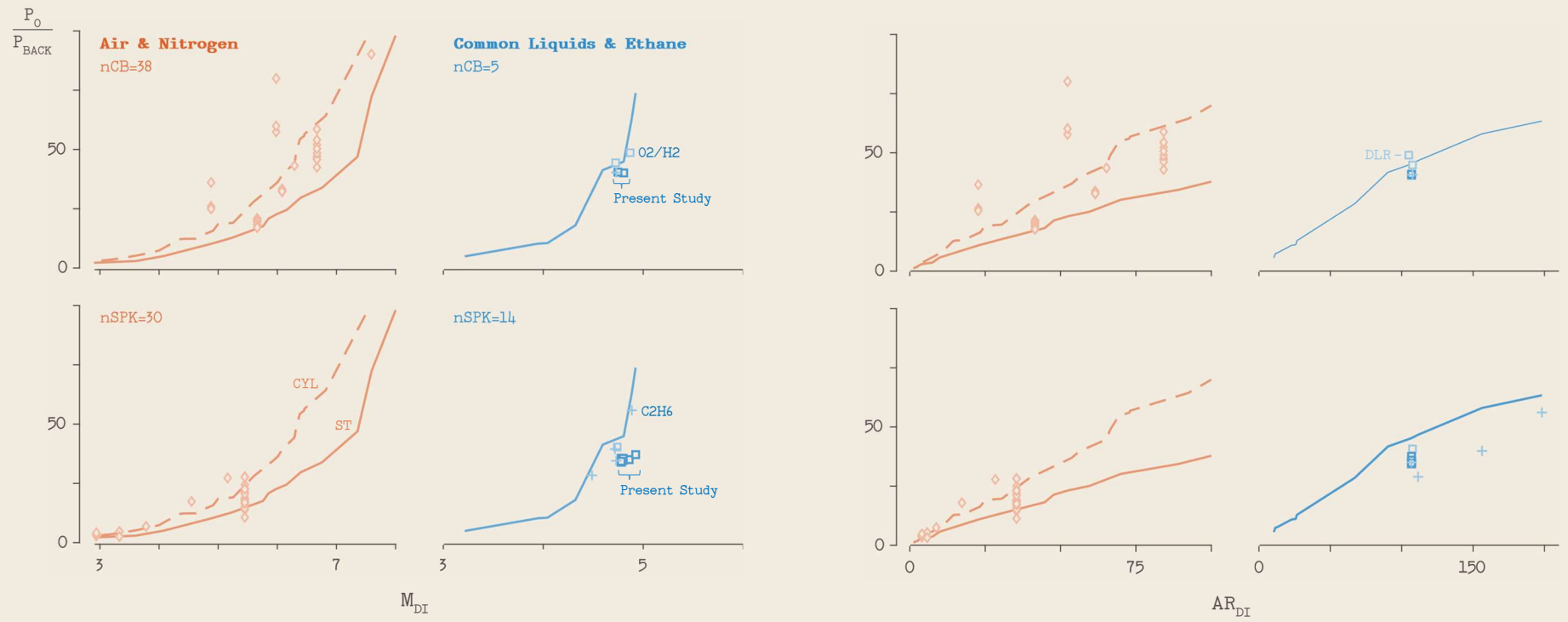


Figure 25. Centerbody and spike diffuser starting performance plotted alongside cylindrical and second-throat empirical frontiers.

Table 5.1 - Hot-Fire Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | | |
|-----|------|------------|------|----------------------|-----|------|-------------------------|------------------------------|------------------------------------|--------------------------|----------|------------------------------------|-----------------|------------------------------------|------------------------------------|------------------------------------|-----------------|-----------------|------------------|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|--|-----------|
| | | | | Propellants | O:F | Type | D _{NT} [cm] | Ref. P ₀ [MPa] | A _{NE} A _{NT} | θ _{NE} [deg] | Name | A _{DI} A _{NT} | M _{DI} | A _{DT} A _{DI} | A _{DT} A _{NE} | A _{DE} A _{DT} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} D _{DI} | L _{DT} D _{DT} | L _D D _{DT} | P ₀ P _{BACK} | (P _{CELL} P ₀) × 10 ⁵ | |
| | | | | | | | | | | | | | | | | | | | | | | | | | < [deg] > |
| 1 | [1] | NASA LaRC | 1958 | Ballistite | NR | CON | 3.45 | 11.7 | 44.0 | 15.0 | - | 53.7 | 4.69 | 1.00 | 1.22 | - | - | 0 | - | - | 1.8 | 1.8 | 95.0 | 84.0 | 132 |
| 2 | [1] | NASA LaRC | 1958 | Ballistite | NR | CON | 3.45 | 11.7 | 44.0 | 15.0 | - | 53.7 | 4.68 | 1.00 | 1.22 | - | - | 0 | - | - | 9.0 | 9.0 | 84.0 | NR | 150 |
| 3 | [1] | NASA LaRC | 1958 | Ballistite | NR | CON | 3.45 | 11.7 | 44.0 | 15.0 | - | 53.7 | 4.69 | 1.00 | 1.22 | - | - | 0 | - | - | 13.8 | 13.8 | 95.0 | 30.0 | 172 |
| 4 | [1] | NASA LaRC | 1958 | Ballistite | NR | CON | 2.18 | 11.7 | 88.2 | 15.0 | - | 108 | 5.22 | 1.00 | 1.22 | - | - | 0 | - | - | 13.8 | 13.8 | 105.0 | 80.0 | 64.1 |
| 5 | [2] | NASA LeRC | 1959 | LF2/LH2 | 3.9 | TOP | 9.95 | 5.0 | 25.0 | NR | - | 28.0 | 3.99 | 1.00 | 1.12 | NR | 6 | 0 | 5 | NR | NR | 9.8 | 24.8 | 24.8 | 177 |
| 6 | [2] | NASA LeRC | 1959 | LF2/LH2 | 3.9 | TOP | 9.95 | 5.0 | 25.0 | NR | - | 28.0 | 3.93 | 0.53 | 0.59 | NR | 6 | 0 | 5 | NR | NR | 7.1 | 13.6 | NR | 254 |
| 7 | [2] | NASA LeRC | 1959 | LF2/LH2 | 3.9 | TOP | 9.95 | 5.0 | 100 | 9.0 | - | 107 | 5.50 | 0.46 | 0.49 | NR | 6 | 0 | 5 | NR | 5.3 | 6.3 | 49.3 | NR | 49.7 |
| 8 | [3] | NASA LeRC | 1959 | LF2/LH2 | 3.9 | CON | 9.95 | 0.4 | 100 | 15.0 | - | 107 | 4.76 | 0.46 | 0.49 | NR | 6 | 0 | 5 | NR | 5.3 | 6.3 | 44.5 | NR | NR |
| 9 | [4] | NASA LeRC | 1959 | LOX/JP-4 | 2.5 | CON | 3.05 | 4.1 | 25.0 | 15.0 | - | 28.4 | 4.14 | 1.00 | 1.14 | - | - | 0 | - | - | 6.6 | 6.6 | 20.5 | 20.5 | 695 |
| 10 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 11.6 | 3.47 | 1.00 | 2.00 | - | - | 0 | - | - | 10.0 | 10.0 | 9.6 | 9.6 | 271 |
| 11 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 13.5 | 3.59 | 1.00 | 2.34 | - | - | 0 | - | - | 9.7 | 9.7 | 10.0 | 10.0 | 24.0 |
| 12 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 23.4 | 4.01 | 1.00 | 4.04 | - | - | 0 | - | - | 8.1 | 8.1 | 18.6 | 18.6 | 113 |
| 13 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 10.8 | 3.42 | 1.00 | 1.87 | 1.7 | - | 0 | 3.5 | - | 10.5 | 15.6 | 9.0 | 9.0 | 311 |
| 14 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 52.0 | 4.63 | 1.00 | 8.99 | 1.7 | - | 0 | 3.5 | - | 11.7 | 16.8 | 39.6 | 39.6 | 45.5 |
| 15 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 5.8 | 15.0 | - | 79.6 | 4.99 | 1.00 | 13.8 | 1.7 | - | 0 | 3.5 | - | 16.0 | 21.1 | 63.0 | 63.0 | 25.4 |
| 16 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 9.6 | 15.0 | - | 13.5 | 3.59 | 1.00 | 1.41 | - | - | 0 | - | - | 9.7 | 9.7 | 10.4 | 10.4 | 260 |
| 17 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 9.6 | 15.0 | - | 23.3 | 4.00 | 1.00 | 2.43 | - | - | 0 | - | - | 8.1 | 8.1 | 17.8 | 17.8 | 95.5 |
| 18 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 9.6 | 15.0 | - | 52.0 | 4.63 | 1.00 | 5.43 | - | - | 0 | - | - | 11.7 | 11.7 | 39.6 | 39.6 | 27.8 |
| 19 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 9.6 | 15.0 | - | 79.7 | 4.99 | 1.00 | 8.32 | 1.6 | - | 0 | 3.5 | - | 16.0 | 20.3 | 59.4 | 59.4 | 16.8 |
| 20 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 19.5 | 15.0 | - | 23.2 | 4.00 | 1.00 | 1.19 | - | - | 0 | - | - | 8.1 | 8.1 | 16.5 | 16.5 | 158 |
| 21 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 19.5 | 15.0 | - | 52.3 | 4.63 | 1.00 | 2.68 | 1.7 | - | 0 | 3.5 | - | 11.7 | 16.8 | 39.2 | 39.2 | 23.0 |
| 22 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 19.5 | 15.0 | - | 79.6 | 4.99 | 1.00 | 4.08 | 1.7 | - | 0 | 3.5 | - | 16.0 | 21.1 | 60.0 | 60.0 | 11.7 |
| 23 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 19.5 | 15.0 | - | 123 | 5.33 | 1.00 | 6.28 | 1.7 | - | 0 | 3.5 | - | 10.0 | 15.1 | 60.8 | 60.8 | 9.9 |
| 24 | [5] | EAFB | 1960 | JPN Ballistite | NR | CON | 2.13 | 8.4 | 63.2 | 15.0 | - | 79.7 | 4.99 | 1.00 | 1.26 | 1.7 | - | 0 | 3.5 | - | 16.0 | 21.1 | 52.0 | 52.0 | 18.3 |
| 25 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 25.7 | 4.04 | 0.80 | 1.01 | - | 5 | 0 | - | 0.06 | 4.5 | 6.0 | 17.1 | 17.1 | NR |
| 26 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | 1A | 25.7 | 4.04 | 0.80 | 1.01 | - | 5 | 0 | - | 0.06 | 8.5 | 10.0 | 16.6 | 16.6 | NR |
| 27 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 0 | 0 | 10 | 0.06 | 10.0 | 12.9 | 11.2 | 11.2 | NR |
| 28 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | 3 | 22.5 | 3.93 | 0.58 | 0.65 | 4 | 5 | 0 | 6.5 | 0.07 | 10.0 | 13.6 | 11.5 | 10.5 | NR |
| 29 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 5 | 0 | 6.5 | 0.06 | 6.0 | 9.9 | 12.2 | 11.9 | NR |
| 30 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 5 | 1.0 | 6.5 | 0.06 | 9.5 | 12.3 | 12.6 | 12.6 | NR |
| 31 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 5 | 0 | 10 | 0.06 | 10.0 | 13.1 | 11.5 | 11.5 | NR |
| 32 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 22.5 | 3.93 | 0.58 | 0.65 | 4 | 5 | 0 | 6.5 | 0.07 | 10.0 | 14.2 | 15.6 | 10.9 | NR |
| 33 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | 2A | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 5 | 0 | 10 | 0.06 | 10.0 | 13.9 | 15.6 | 12.0 | NR |
| 34 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | CON | 1.40 | 1.0 | 20.3 | 17.8 | 3 | 25.7 | 4.04 | 0.51 | 0.65 | 4 | 5 | 0 | 10 | 0.06 | 10.0 | 13.1 | 11.7 | 11.7 | NR |
| 35 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | CON | 1.40 | 1.0 | 20.3 | 17.8 | 2A | 24.1 | 3.99 | 0.54 | 0.65 | 2 | 5 | 0 | 6.5 | 0.07 | 10.0 | 13.1 | 16.5 | 12.3 | NR |
| 36 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 1.40 | 1.0 | 20.3 | 12.8 | - | 20.5 | 3.85 | 0.53 | 0.54 | 4 | -7 | 0 | 6.5 | - | 10.0 | 13.8 | 11.5 | 10.6 | NR |
| 37 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 13.77 | 1.0 | 20.0 | 12.8 | I | 23.0 | 3.95 | 0.58 | 0.66 | 1.7 | 5 | 0 | 6.2 | 0.06 | 10.1 | 19.9 | 12.7 | 10.3 | 54.2 |
| 38 | [6] | NASA JPL | 1960 | N2H4/N2O4 | 1.0 | TOC | 13.79 | 1.0 | 20.4 | 12.8 | II | 22.9 | 3.95 | 0.58 | 0.65 | 1.7 | 5 | 0 | 6.2 | 0.09 | 10.1 | 17.5 | 11.0 | 11.0 | 45.0 |
| 39 | [7] | NASA LeRC | 1960 | LOX/JP-4 | 2.5 | CON | 3.05 | 4.1 | 25.0 | 15.0 | - | 28.4 | 3.72 | 1.00 | 1.14 | - | - | 0 | - | - | 6.6 | 6.6 | 17.0 | 17.0 | NR |
| 40 | [7] | NASA LeRC | 1960 | LOX/JP-4 | 2.5 | CON | 3.05 | 4.1 | 50.2 | 15.0 | - | 56.3 | 4.24 | 1.00 | 1.12 | - | - | 0 | - | - | 10.4 | 10.4 | 34.0 | 34.0 | NR |
| 41 | [8] | Rocketdyne | 1960 | LOX/JP-4 | 2.5 | TOP | 5.84 | 1.8 | 20.0 | 9.0 | ψ=168 | 26.6 | 3.66 | 0.56 | 0.74 | 1.7 | 15 | 0 | 15 | - | 1.0 | 2.3 | 12.9 | NR | 1079 |
| 42 | [9] | P&W | 1960 | LOX/LH2 | 5.0 | TOP | 2.54 | NR | 10.0 | 9.0 | S7 | 10.4 | 3.22 | 0.56 | 0.58 | 2.5 | 5.6 | 0.5 | 5.0 | - | 6.6 | 11.6 | 5.6 | NR | NR |
| 43 | [9] | P&W | 1960 | LOX/LH2 | 5.0 | TOP | 1.27 | NR | 40.0 | 9.0 | S7 | 41.5 | 4.32 | 0.56 | 0.58 | 2.5 | 5.6 | 0.5 | 5.0 | - | 6.6 | 11.6 | 18.7 | NR | NR |
| 44 | [9] | P&W | 1960 | LOX/LH2 | 5.0 | TOP | 12.70 | 2.1 | 40.0 | 9.0 | S8 | 41.5 | 4.32 | 0.56 | 0.58 | 2.5 | 5.6 | 0.5 | 5.0 | - | 6.6 | 11.6 | 19.0 | NR | NR |
| 45 | [36] | NASA SSC | 1991 | LOX/LH2 | 6.0 | TOP | 26.18 | 20.7 | 77.5 | 5.4 | B-1 | 112 | 4.92 | 0.74 | 1.07 | - | 4.7 | 0 | - | - | 5.3 | 6.3 | 74.5 | 64.6 | 160 |
| 46 | [36] | NASA SSC | 1995 | LOX/LH2 | 6.0 | TOP | 26.18 | 20.7 | 77.5 | 5.4 | A-2 | 112 | 4.92 | 0.74 | 1.07 | - | 4.7 | 0 | - | - | 5.3 | 6.3 | 76.3 | 69.7 | 177 |
| 47 | [36] | NASA SSC | 1996 | LOX/LH2 | 6.0 | TOP | 27.64 | 18.9 | 69.4 | 5.4 | B-1 | 100 | 4.83 | 0.74 | 1.08 | - | 4.7 | 0 | - | - | 5.3 | 6.3 | 72.1 | 66.3 | 160 |
| 48 | [36] | NASA SSC | 1997 | LOX/LH2 | 6.0 | TOP | 27.64 | 18.9 | 69.4 | 5.4 | A-2 | 100 | 4.83 | 0.74 | 1.08 | - | 4.7 | 0 | - | - | 5.3 | 6.3 | 71.8 | 59.5 | 162 |
| 49 | [37] | ISRO | 1998 | AP/(HTPB+AL) | 2.1 | CON | NR | 4.0 | 20.0 | 20.5 | Agni SED | 34.2 | 3.67 | 1.00 | 1.71 | 1.3 | - | 0 | 5.5 | - | 8.7 | 8.7 | 24.7 | 24.7 | 303 |
| 50 | [37] | ISRO | 1998 | AP/(HTPB+AL) | 2.1 | CON | NR | 4.0 | 20.0 | 20.5 | Agni SED | 35.5 | 3.70 | 1.00 | 1.77 | 1.3 | - | 0 | 5.5 | - | 8.0 | 8.0 | 26.8 | 26.8 | 280 |
| 51 | [37] | ISRO | 1998 | AP/(HTPB+AL) | 2.1 | CON | NR | 4.0 | 20.0 | 20.5 | Agni SED | 36.7 | 3.71 | 1.00 | 1.84 | 1.3 | - | 0 | 5.5 | - | 10.6 | 10.6 | 24.0 | 24.0 | 313 |
| 52 | [37] | ISRO | 1998 | AP/(HTPB+AL) | 2.1 | PS-3 | 8.00 | 4.0 | 50.0 | NR | PS-3 SED | 64.0 | 4.09 | 1.00 | 1.28 | 4 | - | 0 | 5.5 | - | 9.2 | 13.8 | 41.4 | 40.0 | 60.4 |
| 53 | [38] | NASA SSC | 2013 | LOX/LH2 | 5.5 | TOP | 30.43 | 9.2 | 61.2 | 13.9 | A-2 | 82.8 | 4.80 | 0.74 | 1.01 | - | 4.7 | 0 | - | - | 5.3 | 6.3 | 46.4 | 39.1 | 64.5 |
| 54 | [32] | NASA SSC | 2015 | LOX/GH2 | 5.9 | TOP | 2.62 | 7.9 | 36.5 | 6.0 | JTI | 53.2 | 4.26 | 0.65 | 0.95 | - | 8.3 | 0 | - | - | 3.5 | 4.3 | 27.7 | 24.8 | 197 |
| 55 | [32] | NASA SSC | 2015 | LOX/GH2 | 5.9 | TOP | 2.62 | 7.9 | 36.5 | 6.0 | ND4 | 47.5 | 4.18 | 0.57 | 0.74 | - | 6 | 0 | - | 0.44 | 2.8 | 4.9 | 27.6 | 25.4 | 155 |
| 56 | [32] | NASA SSC | 2015 | LOX/GH2 | 5.9 | TOP | 2.62 | 7.9 | 36.5 | 6.0 | ND11 | 47.5 | 4.18 | 0.50 | 0.65 | - | 6 | 0 | - | 0.44 | 2.6 | 5.2 | 26.7 | 25.3 | 204 |
| 57 | [32] | NASA SSC | 2015 | LOX/GH2 | 5.9 | TOP | 2.62 | 7.9 | 36.5 | 6.0 | ND4B | 53.2</ | | | | | | | | | | | | | |

Table 5.2 - Intermediate Cylindrical and Second-Throat Diffuser Data

| | | | | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | |
|-----|-------|----------|------|----------------------|-------|-----------------|---------------------|----------------------------------|-----------------|------------------------|----------------------------------|-----------------|----------------------------------|----------------------------------|----------------------------------|-----------------|-----------------|------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|---|------|
| No. | Ref. | Entity | Year | Propellants | Type | D _{NT} | Ref. P ₀ | A _{NE} /A _{NT} | α _{NE} | Name | A _{DI} /A _{NT} | M _{DI} | A _{DT} /A _{DI} | A _{DT} /A _{NE} | A _{DE} /A _{DT} | α _{DI} | α _{DT} | α _{SUB} | L _{DI} /D _{DI} | L _{DT} /D _{DT} | L _D /D _{DT} | P ₀ /P _{BACK} | (P _{CELL} /P ₀) x10 ⁵ | |
| | | | | | | | | | | < [deg] > | | | | | | | | | | Start | Unst. | | | |
| | | | | [cm] | [MPa] | [deg] | | | | | | | | | | | | | | | | | | |
| 84 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 1.00 | 1.01 | - | - | - | - | - | 11.6 | 11.6 | 16.3 | 16.3 | NR |
| 85 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | 1B | 20.5 | 4.23 | 1.00 | 1.01 | - | - | - | - | - | 13.6 | 13.6 | 16.1 | 16.1 | NR |
| 86 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 1.00 | 1.01 | - | - | - | - | - | 15.6 | 15.6 | 15.9 | 15.9 | NR |
| 87 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 1.00 | 1.01 | - | - | - | - | - | 19.6 | 19.6 | 15.6 | 15.6 | NR |
| 88 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 1.00 | 1.01 | - | - | - | - | - | 24.0 | 24.0 | 15.4 | 15.4 | NR |
| 89 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.8 | 4.41 | 1.00 | 1.22 | - | - | - | - | - | 5.1 | 5.1 | 21.7 | 21.7 | NR |
| 90 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.8 | 4.41 | 1.00 | 1.22 | - | - | - | - | - | 8.8 | 8.8 | 19.4 | 19.4 | NR |
| 91 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.8 | 4.41 | 1.00 | 1.22 | - | - | - | - | - | 12.4 | 12.4 | 19.1 | 19.1 | NR |
| 92 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.8 | 4.41 | 1.00 | 1.22 | - | - | - | - | - | 17.8 | 17.8 | 19.0 | 19.0 | NR |
| 93 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.8 | 4.41 | 1.00 | 1.22 | - | - | - | - | - | 21.8 | 21.8 | 18.9 | 18.9 | NR |
| 94 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 3.0 | 3.0 | 22.3 | 22.3 | NR |
| 95 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 4.7 | 4.7 | 18.9 | 18.9 | NR |
| 96 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 6.3 | 6.3 | 18.7 | 18.7 | NR |
| 97 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 8.0 | 8.0 | 18.7 | 18.7 | NR |
| 98 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 9.7 | 9.7 | 18.7 | 18.7 | NR |
| 99 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 13.0 | 13.0 | 18.7 | 18.7 | NR |
| 100 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 16.3 | 16.3 | 18.5 | 18.5 | NR |
| 101 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 29.5 | 4.57 | 1.00 | 1.46 | - | - | - | - | - | 20.0 | 20.0 | 18.3 | 18.3 | NR |
| 102 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.72 | 0.72 | 1.8 | 3.0 | 0.0 | 6.5 | - | 0.5 | 3.2 | 19.0 | 19.0 | NR |
| 103 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.65 | 0.66 | 2.0 | 3.0 | 0.0 | 6.5 | 0.94 | 0.5 | 3.8 | 15.9 | 14.1 | NR |
| 104 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.65 | 0.66 | - | 3.0 | 0.0 | - | - | 12.0 | 11.5 | 15.1 | 11.5 | NR |
| 105 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.65 | 0.66 | 2.0 | 3.0 | 0.0 | 6.5 | - | 12.0 | 13.0 | 15.8 | 10.5 | NR |
| 106 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.65 | 0.66 | 2.0 | 3.0 | 0.0 | 6.5 | - | 12.0 | 14.9 | 15.9 | 10.6 | NR |
| 107 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 20.5 | 4.23 | 0.65 | 0.66 | 2.0 | 3.0 | 0.0 | 6.5 | 0.94 | 12.0 | 15.0 | 17.2 | 10.6 | NR |
| 108 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 3.0 | 0.0 | 6.5 | 1.65 | 12.0 | 16.0 | 17.4 | 10.6 | NR |
| 109 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.63 | 0.75 | 2.0 | 3.0 | 0.0 | 6.5 | 1.65 | 12.0 | 16.1 | 22.4 | NR | NR |
| 110 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 3.0 | 7.8 | 15.7 | 14.7 | NR |
| 111 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 4.0 | 8.7 | 15.7 | 13.2 | NR |
| 112 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 5.0 | 9.5 | 15.7 | 11.4 | NR |
| 113 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 6.0 | 10.3 | 15.7 | 11.2 | NR |
| 114 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | 2B | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 8.0 | 11.9 | 15.7 | 10.7 | NR |
| 115 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 10.0 | 13.4 | 15.7 | 10.7 | NR |
| 116 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 24.1 | 4.38 | 0.54 | 0.65 | 2.0 | 5.0 | 0.0 | 6.5 | 0.07 | 12.0 | 15.1 | 15.7 | 10.4 | NR |
| 117 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 25.7 | 4.44 | 0.51 | 0.65 | 4.0 | 5.0 | 0.0 | 10 | 0.06 | 10.0 | 15.6 | 12.3 | 10.2 | NR |
| 118 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | 3 | 25.7 | 4.44 | 0.51 | 0.65 | 4.0 | 5.0 | 0.0 | 10 | 0.06 | 10.0 | 13.1 | 10.4 | 9.8 | NR |
| 119 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 25.7 | 4.44 | 0.51 | 0.65 | 4.0 | 5.0 | 0.0 | 6.5 | 0.06 | 10.0 | 13.5 | 10.2 | 9.8 | NR |
| 120 | [6] | NASA JPL | 1960 | Decomposed N2H4 | TOC | 1.402 | 1.03 | 20.3 | 12.8 | - | 25.7 | 4.44 | 0.51 | 0.65 | 4.0 | 0.0 | 0.0 | 6.5 | 0.06 | 10.0 | 13.7 | 10.2 | 9.7 | NR |
| 121 | [4.3] | NASA JPL | 1983 | CH3OH:Air = 32:26 | CON | 4.039 | 0.69 | 9.9 | 10.0 | NR | 9.9 | 4.08 | 0.72 | 0.72 | NR | 0.0 | 0.0 | 8.0 | NR | NR | 11.0 | 5.7 | 5.7 | 4768 |
| 122 | [4.4] | NASA SSC | 2020 | C2H6, TO=535 K | TOP | 0.318 | 5.00 | 76.9 | 19.1 | CDF-E | 107.6 | 4.73 | 0.46 | 0.64 | 2 | 3.6 | 0.0 | 3.5 | - | 7.3 | 14.0 | 48.0 | 32.4 | 125 |
| 123 | [4.2] | NASA SSC | 2020 | C2H6, TO=535 K | TOP | 0.343 | 18.94 | 69.4 | 5.4 | ND4-E | 90.4 | 4.60 | 0.57 | 0.74 | - | 6.0 | 0.0 | - | 0.44 | 2.8 | 4.9 | 57.8 | 47.3 | 83 |
| 124 | [4.2] | NASA SSC | 2020 | C2H6, TO=535 K | TOP | 0.475 | 9.89 | 36.5 | 6.0 | ND4-E | 47.5 | 4.12 | 0.57 | 0.74 | - | 6.0 | 0.0 | - | 0.44 | 2.8 | 4.9 | 26.9 | 25.5 | 151 |
| 125 | [4.2] | NASA SSC | 2020 | C2H6, TO=635 K | TOP | 0.485 | 10.34 | 60.0 | 20 | SRP-2 | 67.0 | 4.16 | 0.50 | 0.45 | 2.0 | 6.0 | 0.0 | 3.5 | - | 8.0 | 13.4 | 28.6 | 23.1 | 309 |
| 126 | [4.2] | NASA SSC | 2020 | C2H6, TO=635 K | TOP | 0.376 | 10.34 | 100 | 15 | SRP-2 | 111.5 | 4.49 | 0.50 | 0.45 | 2.0 | 6.0 | 0.0 | 3.5 | - | 8.0 | 13.4 | 47.0 | 43.9 | 128 |
| 127 | [4.2] | NASA SSC | 2020 | C2H6, TO=635 K | TOP | 0.318 | 10.34 | 140 | 11 | SRP-2 | 156.3 | 4.72 | 0.50 | 0.45 | 2.0 | 6.0 | 0.0 | 3.5 | - | 8.0 | 14 | 58.4 | 48.4 | 66 |
| 128 | [4.2] | NASA SSC | 2020 | C2H6, TO=635 K | TOP | 0.282 | 10.34 | 177 | 7.5 | SRP-2 | 198.2 | 4.89 | 0.50 | 0.45 | 2.0 | 6.0 | 0.0 | 3.5 | - | 8.0 | 13.4 | 63.8 | 59.2 | 55 |
| 129 | [4.2] | NASA SSC | 2021 | C2H6, TO=515 K | FAIR | 0.318 | 4.39 | 15.0 | 0.0 | CYL-E | 36.2 | 3.97 | 1.00 | 2.41 | - | - | - | - | - | 11.6 | 11.6 | 30.8 | 28.2 | 516 |

Table 5.3 - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| | | | | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|-------|-----------|------|----------------------|----------------|--------|-----------------|---------------------|----------------------------------|------------------------|-----------|----------------------------------|-----------------|----------------------------------|----------------------------------|----------------------------------|-----------------|-----------------|------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|---|----|
| No. | Ref. | Entity | Year | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | A _{NE} /A _{NT} | α _{NE} | Name | A _{DI} /A _{NT} | M _{DI} | A _{DT} /A _{DI} | A _{DT} /A _{NE} | A _{DE} /A _{DT} | α _{DI} | α _{DT} | α _{SUB} | L _{DI} /D _{DI} | L _{DT} /D _{DT} | L _D /D _{DT} | P ₀ /P _{BACK} | (P _{CELL} /P ₀) x10 ⁵ | |
| | | | | [K] | [deg] | | | | | | < [deg] > | | | | | | | | | | Start | Unst. | | | |
| | | | | [cm] | [MPa] | | | | | | | | | | | | | | | | | | | | |
| 130 | [4.5] | NACA LaRC | 1945 | Air | NR | WT | - | NR | NR | 0.0 | - | 1.19 | 1.52 | 0.92 | - | NR | 8.0 | - | 3.0 | 0.1 | - | NR | 1.1 | NR | NR |
| 131 | [4.5] | NACA LaRC | 1945 | Air | NR | WT | - | NR | NR | 0.0 | - | 1.52 | 1.68 | 0.88 | - | NR | 18 | - | 3.0 | 0.1 | - | NR | 1.1 | NR | NR |
| 132 | [4.5] | NACA LaRC | 1945 | Air | NR | WT | - | NR | NR | 0.0 | - | 2.58 | 2.48 | 0.77 | - | NR | 20 | - | 3.0 | 0.2 | - | NR | 1.8 | NR | NR |
| 133 | [34] | NAVORD | 1952 | Air | 300 | 2D WT | 11.50 | 0.10 | 1.6 | 0.0 | - | 1.57 | 1.91 | 0.93 | 0.93 | 1.1 | 1.6 | - | 0.2 | 1.4 | 0.0 | 12.7 | 1.5 | NR | NR |
| 134 | [34] | NAVORD | 1952 | Air | 300 | 2D WT | 6.79 | 0.10 | 2.7 | 0.0 | - | 2.65 | 2.51 | 0.80 | 0.80 | 1.3 | 1.1 | - | 0.8 | 1.4 | 0.0 | 12.7 | 2.1 | NR | NR |
| 135 | [34] | NAVORD | 1952 | Air | 300 | 2D WT | 4.90 | 0.10 | 3.7 | 0.0 | - | 3.68 | 2.85 | 0.73 | 0.73 | 1.4 | 1.6 | - | 1.1 | 1.4 | 0.0 | 12.7 | 2.9 | NR | NR |
| 136 | [34] | NAVORD | 1952 | Air | 300 | 2D WT | 0.76 | 0.10 | 23.8 | 0.0 | - | 23.8 | 4.94 | 0.55 | 0.58 | 1.8 | 3.8 | - | 1.7 | 1.4 | 0.0 | 12.7 | 20.0 | NR | NR |
| 137 | [4.6] | NAVORD | 1952 | Air | 603 | 2D CON | 0.10 | 2.12 | 118 | 5.6 | - | 118 | 7.20 | 0.35 | 0.35 | 1.7 | 3.7 | - | 3.0 | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | |
|-----|---------|-----------|------|----------------------|----------------|----------|-----------------|---------------------|-------------------------|---------------|------------------------|-------------------------|-----------------|-------------------------|-------------------------|-------------------------|---------------|---------------|----------------|-------------------------|-------------------------|----------------------|------------------------|------------------------------------|------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | Name | $\frac{A_{DI}}{A_{NI}}$ | M _{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | θ_{DI} | θ_{DT} | θ_{SUB} | $\frac{L_{DI}}{D_{DI}}$ | $\frac{L_{DT}}{D_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{P_0}{P_{BACK}}$ | $\frac{P_{CELL}}{P_0} \times 10^5$ | |
| | | | | [K] | [cm] | [MPa] | [deg] | | | | | | | | | | | | | | | | Start | Unst. | |
| 158 | [46] | NAVORD | 1952 | Air | 289 | 2D Wedge | 0.03 | 3.04 | 4.65 | 5.6 | - | 4.65 | 9.70 | NR | NR | NR | NR | - | NR | - | 0.0 | NR | 265.0 | NR | NR |
| 159 | [47] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.6 | 18 | a | 7.50 | 3.61 | 1.00 | 2.11 | 11.1 | - | 0 | 4.0 | - | 3.0 | 19.6 | 5.8 | 5.8 | 1030 |
| 160 | [47] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.6 | 18 | b | 13.2 | 4.24 | 1.00 | 3.70 | 6.3 | - | 0 | 4.0 | - | 3.0 | 13.7 | 9.9 | 9.9 | 543 |
| 161 | [47] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.6 | 18 | c | 20.8 | 4.77 | 1.00 | 5.83 | 4.0 | - | 0 | 4.0 | - | 3.0 | 10.1 | 15.9 | 15.9 | 277 |
| 162 | [47] | AEDC | 1959 | Air | 478 | CON | 4.72 | 0.31 | 5.0 | 18 | a | 10.6 | 3.99 | 1.00 | 2.12 | 11.1 | - | 0 | 4.0 | - | 3.0 | 19.6 | 8.0 | 8.0 | 585 |
| 163 | [47] | AEDC | 1959 | Air | 478 | CON | 4.72 | 0.31 | 5.0 | 18 | b | 18.5 | 4.63 | 1.00 | 3.70 | 6.3 | - | 0 | 4.0 | - | 3.0 | 13.7 | 13.8 | 13.8 | 387 |
| 164 | [47] | AEDC | 1959 | Air | 478 | CON | 4.72 | 0.31 | 5.0 | 18 | c | 29.2 | 5.20 | 1.00 | 5.83 | 4.0 | - | 0 | 4.0 | - | 3.0 | 10.1 | 22.1 | 22.1 | 160 |
| 165 | [47] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | a | 23.0 | 4.90 | 1.00 | 2.13 | 11.1 | - | 0 | 4.0 | - | 3.0 | 19.6 | 16.7 | 16.7 | 181 |
| 166 | [47] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | b | 39.8 | 5.60 | 1.00 | 3.69 | 6.3 | - | 0 | 4.0 | - | 3.0 | 13.7 | 28.9 | 28.9 | 108 |
| 167 | [47] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | c | 62.8 | 6.24 | 1.00 | 5.81 | 4.0 | - | 0 | 4.0 | - | 3.0 | 10.1 | 45.0 | 45.0 | 56.0 |
| 168 | [47] | AEDC | 1959 | Air | 478 | CON | 2.49 | 0.31 | 18 | 18 | a | 38.6 | 5.56 | 1.00 | 2.14 | 11.1 | - | 0 | 4.0 | - | 3.0 | 19.6 | 29.3 | 29.3 | 121 |
| 169 | [47] | AEDC | 1959 | Air | 478 | CON | 2.49 | 0.31 | 18 | 18 | b | 66.4 | 6.32 | 1.00 | 3.69 | 6.3 | - | 0 | 4.0 | - | 3.0 | 13.7 | 49.0 | 49.0 | 66.0 |
| 170 | [47] | AEDC | 1959 | Air | 478 | CON | 2.49 | 0.31 | 18 | 18 | c | 105 | 7.01 | 1.00 | 5.81 | 4.0 | - | 0 | 4.0 | - | 3.0 | 10.1 | 74.1 | 74.1 | 34.8 |
| 171 | [47] | AEDC | 1959 | Air | 478 | CON | 2.11 | 0.31 | 25 | 18 | a | 53.3 | 6.00 | 1.00 | 2.13 | 11.1 | - | 0 | 4.0 | - | 3.0 | 19.6 | 39.1 | 39.1 | 98.0 |
| 172 | [47] | AEDC | 1959 | Air | 478 | CON | 2.11 | 0.31 | 25 | 18 | b | 92.4 | 6.81 | 1.00 | 3.70 | 6.3 | - | 0 | 4.0 | - | 3.0 | 13.7 | 64.8 | 64.8 | 52.5 |
| 173 | [47] | AEDC | 1959 | Air | 478 | CON | 2.11 | 0.31 | 25 | 18 | c | 14.6 | 7.55 | 1.00 | 5.83 | 4.0 | - | 0 | 4.0 | - | 3.0 | 10.1 | 101.7 | 101.7 | 26.8 |
| 174 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | a | 7.50 | 3.61 | 1.00 | 2.11 | 11.1 | -12 | 0 | 4.0 | - | 3.0 | 19.6 | 6.1 | 6.1 | 402 |
| 175 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | a | 7.50 | 3.61 | 1.00 | 2.11 | 11.1 | -24 | 0 | 4.0 | - | 3.0 | 19.6 | 6.4 | 6.4 | 295 |
| 176 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | a | 7.50 | 3.61 | 1.00 | 2.11 | 11.1 | -18 | 0 | 4.0 | - | 3.0 | 19.6 | 6.7 | 6.7 | 252 |
| 177 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | b | 13.2 | 4.24 | 1.00 | 3.70 | 6.3 | -18 | 0 | 4.0 | - | 3.0 | 13.7 | 10.2 | 10.2 | 179 |
| 178 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | b | 13.2 | 4.24 | 1.00 | 3.70 | 6.3 | -24 | 0 | 4.0 | - | 3.0 | 13.7 | 10.8 | 10.8 | 137 |
| 179 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | c | 20.8 | 4.77 | 1.00 | 5.83 | 4.0 | -24 | 0 | 4.0 | - | 3.0 | 10.1 | 17.2 | 17.2 | 68.0 |
| 180 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | c | 20.8 | 4.77 | 1.00 | 5.83 | 4.0 | -30 | 0 | 4.0 | - | 3.0 | 10.1 | 18.9 | 18.9 | 52.9 |
| 181 | [48] | AEDC | 1959 | Air | 478 | CON | 5.59 | 0.31 | 3.56 | 18 | c | 20.8 | 4.77 | 1.00 | 5.83 | 4.0 | -35 | 0 | 4.0 | - | 3.0 | 10.1 | 16.1 | 16.1 | 48.5 |
| 182 | [48] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | a | 23.0 | 4.90 | 1.00 | 2.13 | 11.1 | -12 | 0 | 4.0 | - | 3.0 | 19.6 | 17.0 | 17.0 | 99.4 |
| 183 | [48] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | a | 23.0 | 4.90 | 1.00 | 2.13 | 11.1 | -24 | 0 | 4.0 | - | 3.0 | 19.6 | 17.5 | 17.5 | 64.6 |
| 184 | [48] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | b | 39.8 | 5.60 | 1.00 | 3.69 | 6.3 | -18 | 0 | 4.0 | - | 3.0 | 13.7 | 30.4 | 30.4 | 60.7 |
| 185 | [48] | AEDC | 1959 | Air | 478 | CON | 3.21 | 0.31 | 10.8 | 18 | b | 39.8 | 5.60 | 1.00 | 3.69 | 6.3 | -30 | 0 | 4.0 | - | 3.0 | 13.7 | 28.7 | 28.7 | 98.1 |
| 186 | [48] | AEDC | 1959 | Air | 478 | CON | 2.49 | 0.31 | 18 | 18 | a | 38.6 | 5.56 | 1.00 | 2.14 | 11.1 | -12 | 0 | 4.0 | - | 3.0 | 19.6 | 39.4 | 39.4 | 53.1 |
| 187 | [48] | AEDC | 1959 | Air | 478 | CON | 2.49 | 0.31 | 18 | 18 | a | 38.6 | 5.56 | 1.00 | 2.14 | 11.1 | -24 | 0 | 4.0 | - | 3.0 | 19.6 | 42.3 | 42.3 | 36.0 |
| 188 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.00" | 16.0 | 4.46 | 1.00 | 2.18 | - | - | 0 | - | - | 12.0 | 12.0 | 14.2 | 14.2 | 282 |
| 189 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.25" | 25.0 | 5.00 | 1.00 | 2.78 | - | - | 0 | - | - | 9.6 | 9.6 | 19.3 | 19.3 | 130 |
| 190 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.50" | 36.0 | 5.47 | 1.00 | 4.00 | - | - | 0 | - | - | 6.7 | 6.7 | 30.8 | 30.8 | 107 |
| 191 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.50" | 36.0 | 5.47 | 1.00 | 4.00 | - | - | 0 | - | - | 5.3 | 5.3 | 28.5 | 28.5 | 87.7 |
| 192 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.50" | 36.0 | 5.47 | 1.00 | 4.00 | - | - | 0 | - | - | 8.0 | 8.0 | 28.5 | 28.5 | 70.2 |
| 193 | [49] | NASA LeRC | 1959 | N2 | AMB | CON | 0.64 | 4.46 | 9.0 | 15 | 1.75" | 49.0 | 5.89 | 1.00 | 5.44 | - | - | 0 | - | - | 6.9 | 6.9 | 38.7 | 38.7 | 64.6 |
| 194 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | a | 7.66 | 3.63 | 1.00 | 2.11 | - | - | 0 | - | - | 1.6 | NR | 11.5 | 7.2 | 1060 |
| 195 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | a | 7.66 | 3.63 | 1.00 | 2.11 | - | - | 0 | - | - | 3.0 | NR | 8.2 | 6.9 | 1060 |
| 196 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | as1 | 7.66 | 3.63 | 1.00 | 2.11 | 10.4 | - | 0 | 4.0 | - | 1.6 | NR | 6.6 | 5.9 | 1030 |
| 197 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | as1 | 7.66 | 3.63 | 1.00 | 2.11 | 10.4 | - | 0 | 4.0 | - | 3.0 | NR | 6.0 | 6.0 | 992 |
| 198 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | as1 | 7.66 | 3.63 | 1.00 | 2.11 | 10.4 | - | 0 | 4.0 | - | 6.0 | NR | 6.3 | 6.1 | 1060 |
| 199 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | as1 | 7.66 | 3.63 | 1.00 | 2.11 | 10.4 | - | 0 | 4.0 | - | 9.0 | NR | 6.1 | 6.1 | 1060 |
| 200 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | cs2 | 21.5 | 4.81 | 1.00 | 5.92 | 3.6 | - | 0 | 4.0 | - | 3.0 | NR | 16.5 | 16.5 | 260 |
| 201 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | cs2 | 21.5 | 4.81 | 1.00 | 5.92 | 3.6 | - | 0 | 4.0 | - | 6.0 | NR | 16.5 | 16.5 | 270 |
| 202 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | cs2 | 21.5 | 4.81 | 1.00 | 5.92 | 3.6 | - | 0 | 4.0 | - | 9.0 | NR | 16.6 | 16.6 | 270 |
| 203 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | as1 | 10.8 | 4.01 | 1.00 | 2.13 | 10.4 | - | 0 | 4.0 | - | 3.0 | NR | 8.2 | 8.2 | 558 |
| 204 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | as1 | 10.8 | 4.01 | 1.00 | 2.13 | 10.4 | - | 0 | 4.0 | - | 6.0 | NR | 8.7 | 8.7 | 553 |
| 205 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | as1 | 10.8 | 4.01 | 1.00 | 2.13 | 10.4 | - | 0 | 4.0 | - | 9.0 | NR | 8.2 | 8.2 | 553 |
| 206 | [33,50] | AEDC | 1960 | Air | 283 | CON | 4.70 | 2.68 | 5.1 | 18 | as3 | 10.8 | 4.01 | 1.00 | 2.13 | 1.9 | - | 0 | 4.0 | - | NR | NR | 8.5 | NR | 553 |
| 207 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | cs2 | 30.3 | 5.24 | 1.00 | 5.97 | 3.6 | - | 0 | 4.0 | - | 3.0 | NR | 22.5 | 22.5 | 162 |
| 208 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | cs2 | 30.3 | 5.24 | 1.00 | 5.97 | 3.6 | - | 0 | 4.0 | - | 6.0 | NR | 22.8 | 22.8 | 152 |
| 209 | [33,50] | AEDC | 1960 | Air | 294 | CON | 4.70 | 2.68 | 5.1 | 18 | cs2 | 30.3 | 5.24 | 1.00 | 5.97 | 3.6 | - | 0 | 4.0 | - | 9.0 | NR | 22.9 | 22.9 | 1568 |
| 210 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | a | 23.3 | 4.91 | 1.00 | 2.15 | - | - | 0 | - | - | 1.6 | NR | 23.7 | 19.6 | 173 |
| 211 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | a | 23.3 | 4.91 | 1.00 | 2.15 | - | - | 0 | - | - | 3.0 | NR | 29.9 | 19.0 | 175 |
| 212 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | as1 | 23.3 | 4.91 | 1.00 | 2.15 | 10.4 | - | 0 | 4.0 | - | 1.6 | NR | 21.8 | 17.4 | 177 |
| 213 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | as1 | 23.3 | 4.91 | 1.00 | 2.15 | 10.4 | - | 0 | 4.0 | - | 3.0 | NR | 16.7 | 16.7 | 181 |
| 214 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | as1 | 23.3 | 4.91 | 1.00 | 2.15 | 10.4 | - | 0 | 4.0 | - | 5.5 | NR | 18.1 | 17.7 | 175 |
| 215 | [33,50] | AEDC | 196 | | | | | | | | | | | | | | | | | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|---------|--------|------|----------------------|----------------|-------|-----------------|---------------------|-------------------------|------------------------|------|-------------------------|-----------------|-------------------------|-------------------------|-------------------------|---------------|---------------|----------------|-------------------------|-------------------------|----------------------|------------------------|---|------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | Name | $\frac{A_{DI}}{A_{NT}}$ | M _{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | θ_{DI} | θ_{DT} | θ_{SUB} | $\frac{L_{DI}}{D_{DI}}$ | $\frac{L_{DT}}{D_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{P_0}{P_{BACK}}$ | $\left(\frac{P_{CELL}}{P_0}\right) \times 10^5$ | |
| | | | | [K] | [cm] | [MPa] | [deg] | | | | | | | | | | | | | | | | Start | Unst. | |
| 241 | [33,50] | AEDC | 1960 | Air | 289 | TOP | 1.12 | 2.68 | 100 | 0 | as3 | 190 | 8.00 | 1.00 | 1.90 | 1.9 | - | 0 | 4.0 | - | NR | NR | 359.0 | NR | 7.46 |
| 242 | [33,50] | AEDC | 1960 | Air | 285 | TOP | 1.12 | 2.68 | 100 | 0 | cs4 | 532 | 9.98 | 1.00 | 1.92 | 1.2 | - | 0 | 4.0 | - | NR | NR | 653.6 | NR | 1.89 |
| 243 | [33,50] | AEDC | 1960 | Air | 328 | NR | 6.05 | 2.68 | 11.0 | 19 | cs2 | 182 | 4.62 | 1.00 | 1.67 | 3.6 | - | 0 | 4.0 | - | NR | NR | 13.0 | NR | 24.1 |
| 244 | [33,50] | AEDC | 1960 | Air | 297 | CON | 5.59 | 2.68 | 3.6 | 18 | a1 | 7.50 | 3.61 | 1.00 | 2.07 | - | - | 0 | - | - | 9.1 | 9.1 | 6.8 | 6.8 | 1060 |
| 245 | [33,50] | AEDC | 1960 | Air | 291 | CON | 3.20 | 2.68 | 10.8 | 18 | a1 | 22.8 | 4.89 | 1.00 | 2.10 | - | - | 0 | - | - | 9.1 | 9.1 | 18.5 | 18.5 | 195 |
| 246 | [33,50] | AEDC | 1960 | Air | 311 | CON | 2.11 | 2.68 | 25.0 | 18 | a1 | 52.5 | 5.98 | 1.00 | 2.10 | - | - | 0 | - | - | 9.1 | 9.1 | 41.3 | 41.3 | 106 |
| 247 | [33,50] | AEDC | 1960 | Air | 297 | TOP | 2.29 | 2.68 | 23.7 | 0 | a1 | 44.7 | 5.76 | 1.00 | 1.89 | - | - | 0 | - | - | 9.1 | 9.1 | 37.9 | 37.9 | 34.5 |
| 248 | [51] | AEDC | 1960 | Air | 300 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.0 | 0.4 | 9.1 | 4.8 | 4.8 | 2080 |
| 249 | [51] | AEDC | 1960 | Air | 313 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.3 | 0.4 | 9.1 | 5.3 | 5.3 | 2080 |
| 250 | [51] | AEDC | 1960 | Air | 332 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 8.7 | 5.9 | 1130 |
| 251 | [51] | AEDC | 1960 | Air | 316 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.7 | 0.4 | 9.1 | 5.6 | 5.6 | 1140 |
| 252 | [51] | AEDC | 1960 | Air | 316 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 5.6 | 5.6 | 1130 |
| 253 | [51] | AEDC | 1960 | Air | 318 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 5.8 | 5.8 | 1130 |
| 254 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 1.7 | 0.4 | 9.1 | 5.8 | 5.8 | 1130 |
| 255 | [51] | AEDC | 1960 | Air | 323 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 2.0 | 0.4 | 9.1 | 5.8 | 5.6 | 1130 |
| 256 | [51] | AEDC | 1960 | Air | 328 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 2.2 | 0.4 | 9.1 | 6.0 | 6.0 | 1130 |
| 257 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 2.2 | 0.4 | 9.1 | 6.0 | 6.0 | 1130 |
| 258 | [51] | AEDC | 1960 | Air | 331 | CON | 5.59 | 0.14 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.0 | 0.4 | 9.1 | 4.9 | 4.9 | 1880 |
| 259 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 1a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 6.0 | 0 | 0.0 | 0.3 | 0.4 | 9.1 | 5.4 | 5.4 | 1770 |
| 260 | [51] | AEDC | 1960 | Air | 314 | CON | 5.59 | 0.28 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 5.9 | 5.3 | 2430 |
| 261 | [51] | AEDC | 1960 | Air | 315 | CON | 5.59 | 0.28 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.4 | 0.3 | 9.1 | 6.0 | 6.0 | 1110 |
| 262 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.7 | 0.3 | 9.1 | 6.0 | 6.0 | 1110 |
| 263 | [51] | AEDC | 1960 | Air | 319 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 1.8 | 0.3 | 9.1 | 5.9 | 5.9 | 1110 |
| 264 | [51] | AEDC | 1960 | Air | 317 | CON | 5.59 | 0.28 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 6.0 | 6.0 | 1110 |
| 265 | [51] | AEDC | 1960 | Air | 319 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 1.2 | 0.3 | 9.1 | 6.1 | 6.1 | 1110 |
| 266 | [51] | AEDC | 1960 | Air | 318 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 1.3 | 0.3 | 9.1 | 6.1 | 6.1 | 1110 |
| 267 | [51] | AEDC | 1960 | Air | 317 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 6.4 | 6.3 | 1110 |
| 268 | [51] | AEDC | 1960 | Air | 313 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 3.0 | 0.3 | 9.1 | 6.8 | 6.3 | 1110 |
| 269 | [51] | AEDC | 1960 | Air | 322 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 4.0 | 0.3 | 9.1 | 6.9 | 6.6 | 1110 |
| 270 | [51] | AEDC | 1960 | Air | 322 | CON | 5.59 | 0.27 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 6.0 | 0.3 | 9.1 | 6.8 | 6.8 | 1110 |
| 271 | [51] | AEDC | 1960 | Air | 322 | CON | 5.59 | 0.21 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 7.2 | 0.3 | 9.1 | 6.9 | 6.8 | 1110 |
| 272 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 5.7 | 5.7 | 2040 |
| 273 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.4 | 0.3 | 9.1 | 6.3 | 6.3 | 1080 |
| 274 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.7 | 0.3 | 9.1 | 6.1 | 6.1 | 1080 |
| 275 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.8 | 0.3 | 9.1 | 6.1 | 6.1 | 1080 |
| 276 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 0.8 | 0.3 | 9.1 | 6.1 | 6.1 | 1080 |
| 277 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 6.2 | 6.1 | 1080 |
| 278 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 6.5 | 6.5 | 1080 |
| 279 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 4.0 | 0.3 | 9.1 | 7.0 | 6.8 | 1080 |
| 280 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 6.0 | 0.3 | 9.1 | 7.0 | 6.9 | 1080 |
| 281 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.14 | 3.6 | 18 | 2a | 7.49 | 3.61 | 0.80 | 1.65 | 1.3 | 12.0 | 0 | 0.0 | 7.2 | 0.3 | 9.1 | 7.0 | 7.0 | 1080 |
| 282 | [51] | AEDC | 1960 | Air | 310 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.2 | 0.3 | 9.1 | 4.7 | 4.7 | 2710 |
| 283 | [51] | AEDC | 1960 | Air | 318 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 4.8 | 4.8 | 2380 |
| 284 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.4 | 0.3 | 9.1 | 4.9 | 4.9 | 1910 |
| 285 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.5 | 0.3 | 9.1 | 5.0 | 5.0 | 1120 |
| 286 | [51] | AEDC | 1960 | Air | 326 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.7 | 0.3 | 9.1 | 5.2 | 5.2 | 1110 |
| 287 | [51] | AEDC | 1960 | Air | 327 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.8 | 0.3 | 9.1 | 5.3 | 5.2 | 1100 |
| 288 | [51] | AEDC | 1960 | Air | 326 | CON | 5.59 | 0.25 | 3.6 | 18 | 2b | 7.49 | 3.61 | 0.57 | 1.17 | 1.8 | 12.0 | 0 | 0.0 | 0.8 | 0.3 | 9.1 | 5.2 | 5.2 | 1100 |
| 289 | [51] | AEDC | 1960 | Air | 309 | CON | 5.59 | 0.27 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 0.3 | 0.7 | 9.1 | 4.6 | 4.6 | 2370 |
| 290 | [51] | AEDC | 1960 | Air | 312 | CON | 5.59 | 0.28 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 0.4 | 0.7 | 9.1 | 4.7 | 4.7 | 2010 |
| 291 | [51] | AEDC | 1960 | Air | 313 | CON | 5.59 | 0.27 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 0.5 | 0.7 | 9.1 | 4.7 | 4.6 | 1870 |
| 292 | [51] | AEDC | 1960 | Air | 307 | CON | 5.59 | 0.27 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 0.5 | 0.7 | 9.1 | 4.5 | 4.5 | 5320 |
| 293 | [51] | AEDC | 1960 | Air | 316 | CON | 5.59 | 0.27 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 1.2 | 0.7 | 9.1 | 4.7 | 4.7 | 4640 |
| 294 | [51] | AEDC | 1960 | Air | 316 | CON | 5.59 | 0.27 | 3.6 | 18 | 3a | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 0.7 | 9.1 | 4.8 | 4.8 | 4820 |
| 295 | [51] | AEDC | 1960 | Air | 314 | CON | 5.59 | 0.27 | 3.6 | 18 | 3b | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | 0.3 | 8.0 | 9.1 | 4.1 | 4.1 | 2330 |
| 296 | [51] | AEDC | 1960 | Air | 321 | CON | 5.59 | 0.27 | 3.6 | 18 | 3b | 7.49 | 3.61 | 0.50 | 1.03 | 2.0 | 12.0 | 0 | 0.0 | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|------|--------|------|----------------------|----------------|------|-----------------|---------------------|----------------------------------|------------------------|------|----------------------------------|-----------------|----------------------------------|----------------------------------|----------------------------------|-----------------|-----------------|------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|-----------------------------------|------------------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | A _{NE} /A _{NT} | θ _{NE} | Name | A _{DI} /A _{NT} | M _{DI} | A _{DT} /A _{DI} | A _{DT} /A _{NE} | A _{DE} /A _{DT} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} /D _{DI} | L _{DT} /D _{DT} | L _D /D _{DT} | P ₀ /P _{BACK} | P _{CELL} /P ₀ | x10 ⁵ |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 324 | [51] | AEDC | 1960 | Air | 327 | CON | 5.59 | 0.14 | 3.6 | 18 | 3c | 7.49 | 3.61 | 0.40 | 0.82 | 2.5 | 12.0 | 0 | 0.0 | 0.8 | 0.5 | 9.1 | 3.9 | 3.9 | 13000 |
| 325 | [51] | AEDC | 1960 | Air | 327 | CON | 5.59 | 0.14 | 3.6 | 18 | 3c | 7.49 | 3.61 | 0.40 | 0.82 | 2.5 | 12.0 | 0 | 0.0 | 1.0 | 0.5 | 9.1 | 3.9 | 3.8 | 16100 |
| 326 | [51] | AEDC | 1960 | Air | 327 | CON | 5.59 | 0.14 | 3.6 | 18 | 3c | 7.49 | 3.61 | 0.40 | 0.82 | 2.5 | 12.0 | 0 | 0.0 | 2.0 | 0.5 | 9.1 | 3.9 | 3.8 | 224,00 |
| 327 | [51] | AEDC | 1960 | Air | 327 | CON | 5.59 | 0.14 | 3.6 | 18 | 3c | 7.49 | 3.61 | 0.40 | 0.82 | 2.5 | 12.0 | 0 | 0.0 | 4.0 | 0.5 | 9.1 | 3.9 | 6.1 | 234,00 |
| 328 | [51] | AEDC | 1960 | Air | 322 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 6.1 | 6.0 | 3120 |
| 329 | [51] | AEDC | 1960 | Air | 318 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 8.0 | 8.6 | 1120 |
| 330 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 5.6 | 5.5 | 1110 |
| 331 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.2 | 0.4 | 9.1 | 5.5 | 5.5 | 1110 |
| 332 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 5.5 | 5.5 | 1110 |
| 333 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 5.5 | 5.5 | 1110 |
| 334 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.27 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.7 | 0.4 | 9.1 | 6.6 | 5.6 | 1110 |
| 335 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 6.3 | 5.6 | 34,00 |
| 336 | [51] | AEDC | 1960 | Air | 330 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 6.3 | 5.9 | 1120 |
| 337 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 0.9 | 0.4 | 9.1 | 5.7 | 5.7 | 1120 |
| 338 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 5.6 | 5.6 | 1120 |
| 339 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.1 | 0.4 | 9.1 | 5.6 | 5.6 | 1120 |
| 340 | [51] | AEDC | 1960 | Air | 330 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 5.6 | 5.6 | 1120 |
| 341 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 5.7 | 5.6 | 1120 |
| 342 | [51] | AEDC | 1960 | Air | 329 | CON | 5.59 | 0.14 | 3.6 | 18 | 4a | 7.49 | 3.61 | 0.65 | 1.35 | 1.5 | 18.0 | 0 | 0.0 | 1.5 | 0.4 | 9.1 | 6.7 | 5.8 | 1120 |
| 343 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.28 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 22.2 | 17.2 | 232 |
| 344 | [51] | AEDC | 1960 | Air | 308 | CON | 3.20 | 0.28 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 17.0 | 16.8 | 204 |
| 345 | [51] | AEDC | 1960 | Air | 303 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 16.8 | 16.8 | 199 |
| 346 | [51] | AEDC | 1960 | Air | 321 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.9 | 0.4 | 9.1 | 16.7 | 16.6 | 209 |
| 347 | [51] | AEDC | 1960 | Air | 321 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 16.3 | 16.3 | 209 |
| 348 | [51] | AEDC | 1960 | Air | 322 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.1 | 0.4 | 9.1 | 16.3 | 16.2 | 209 |
| 349 | [51] | AEDC | 1960 | Air | 321 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.2 | 0.4 | 9.1 | 16.6 | 16.5 | 209 |
| 350 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 16.8 | 16.8 | 204 |
| 351 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.5 | 0.4 | 9.1 | 16.9 | 16.9 | 204 |
| 352 | [51] | AEDC | 1960 | Air | 312 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.7 | 0.4 | 9.1 | 17.4 | 17.3 | 201 |
| 353 | [51] | AEDC | 1960 | Air | 369 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 2.0 | 0.4 | 9.1 | 19.8 | 17.6 | 201 |
| 354 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 3.0 | 0.4 | 9.1 | 17.8 | 17.7 | 204 |
| 355 | [51] | AEDC | 1960 | Air | 317 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 4.0 | 0.4 | 9.1 | 18.6 | 18.5 | 206 |
| 356 | [51] | AEDC | 1960 | Air | 318 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 4.9 | 0.4 | 9.1 | 20.5 | 19.9 | 206 |
| 357 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.28 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.6 | 0.4 | 9.1 | 17.0 | 16.9 | 239 |
| 358 | [51] | AEDC | 1960 | Air | 321 | CON | 3.20 | 0.28 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 16.5 | 16.5 | 239 |
| 359 | [51] | AEDC | 1960 | Air | 323 | CON | 3.20 | 0.28 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 4.0 | 0.4 | 9.1 | 18.5 | 18.2 | 242 |
| 360 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 4.3 | 0.4 | 9.1 | 19.7 | 18.8 | 245 |
| 361 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.27 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 4.3 | 0.4 | 9.1 | 20.9 | 18.9 | 245 |
| 362 | [51] | AEDC | 1960 | Air | 331 | CON | 3.20 | 0.14 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.0 | 0.4 | 9.1 | 14.4 | 14.4 | 734 |
| 363 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.14 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.3 | 0.4 | 9.1 | 16.3 | 15.6 | 637 |
| 364 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.14 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 16.3 | 15.6 | 607 |
| 365 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.14 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.6 | 0.4 | 9.1 | 15.8 | 15.8 | 588 |
| 366 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.14 | 10.8 | 18 | 1a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 17.1 | 17.1 | 452 |
| 367 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 15.5 | 15.2 | 447 |
| 368 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 0.5 | 0.3 | 9.1 | 16.5 | 16.5 | 238 |
| 369 | [51] | AEDC | 1960 | Air | 312 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 0.5 | 0.3 | 9.1 | 16.9 | 16.9 | 201 |
| 370 | [51] | AEDC | 1960 | Air | 313 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 0.6 | 0.3 | 9.1 | 17.2 | 17.2 | 201 |
| 371 | [51] | AEDC | 1960 | Air | 314 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 0.6 | 0.3 | 9.1 | 17.5 | 17.5 | 201 |
| 372 | [51] | AEDC | 1960 | Air | 306 | CON | 3.20 | 0.28 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 17.9 | 17.9 | 199 |
| 373 | [51] | AEDC | 1960 | Air | 314 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.3 | 0.3 | 9.1 | 17.6 | 17.6 | 201 |
| 374 | [51] | AEDC | 1960 | Air | 314 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.5 | 0.3 | 9.1 | 17.7 | 17.7 | 201 |
| 375 | [51] | AEDC | 1960 | Air | 314 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.6 | 0.3 | 9.1 | 17.8 | 17.8 | 201 |
| 376 | [51] | AEDC | 1960 | Air | 308 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 18.2 | 18.2 | 199 |
| 377 | [51] | AEDC | 1960 | Air | 308 | CON | 3.20 | 0.27 | 10.8 | 18 | 2a | 22.8 | 4.89 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 13.0 | 0.3 | 9.1 | 18.5 | 18.5 | 199 |
| 378 | [51] | AEDC | 1960 | Air | 308 | CON | 3.20 | 0.27 | 10.8 | 18 | 2 | | | | | | | | | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|------|--------|------|----------------------|----------------|------|-----------------|---------------------|------------------------------------|------------------------|------|------------------------------------|-----------------|------------------------------------|------------------------------------|------------------------------------|-----------------|-----------------|------------------|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|----------------------------------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | A _{NE} A _{NT} | θ _{NE} | Name | A _{DI} A _{NT} | M _{DI} | A _{DT} A _{DI} | A _{DT} A _{NE} | A _{DE} A _{DT} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} D _{DI} | L _{DT} D _{DT} | L _D D _{DT} | P ₀ P _{BACK} | P ₀ P _{CELL} | P ₀ P ₀ |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 407 | [51] | AEDC | 1960 | Air | 310 | CON | 3.20 | 0.27 | 10.8 | 18 | 3a | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.1 | 0.7 | 9.1 | 15.5 | 15.2 | 199 |
| 408 | [51] | AEDC | 1960 | Air | 307 | CON | 3.20 | 0.14 | 10.8 | 18 | 3a | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 0.7 | 9.1 | 15.9 | 15.8 | 509 |
| 409 | [51] | AEDC | 1960 | Air | 310 | CON | 3.20 | 0.14 | 10.8 | 18 | 3a | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.9 | 0.7 | 9.1 | 15.7 | 15.6 | 441 |
| 410 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.14 | 10.8 | 18 | 3a | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 0.7 | 9.1 | 15.9 | 15.8 | 431 |
| 411 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.14 | 10.8 | 18 | 3a | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 0.7 | 9.1 | 29.2 | 18.8 | NR |
| 412 | [51] | AEDC | 1960 | Air | 303 | CON | 3.20 | 0.28 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.3 | 8.0 | 9.1 | 10.9 | 10.9 | 430 |
| 413 | [51] | AEDC | 1960 | Air | 306 | CON | 3.20 | 0.28 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.5 | 8.0 | 9.1 | 12.2 | 12.2 | 199 |
| 414 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.28 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.6 | 8.0 | 9.1 | 11.7 | 11.7 | 200 |
| 415 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.28 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 8.0 | 9.1 | 11.5 | 11.5 | 206 |
| 416 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.28 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.9 | 8.0 | 9.1 | 11.5 | 11.4 | 186 |
| 417 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.14 | 10.8 | 18 | 3b | 22.8 | 4.89 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.6 | 8.0 | 9.1 | 11.2 | 11.2 | 583 |
| 418 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.3 | 0.5 | 9.1 | 12.3 | 12.3 | 425 |
| 419 | [51] | AEDC | 1960 | Air | 322 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.9 | 0.5 | 9.1 | 12.9 | 12.8 | 1100 |
| 420 | [51] | AEDC | 1960 | Air | 322 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 1.0 | 0.5 | 9.1 | 12.5 | 12.5 | 1710 |
| 421 | [51] | AEDC | 1960 | Air | 324 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 1.3 | 0.5 | 9.1 | 12.3 | 12.3 | 2660 |
| 422 | [51] | AEDC | 1960 | Air | 326 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 2.0 | 0.5 | 9.1 | 12.1 | 12.1 | 4460 |
| 423 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 4.0 | 0.5 | 9.1 | 12.1 | 12.1 | 5440 |
| 424 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.27 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 6.0 | 0.5 | 9.1 | 12.1 | 12.1 | 6490 |
| 425 | [51] | AEDC | 1960 | Air | 328 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.2 | 0.5 | 9.1 | 12.2 | 12.2 | 9690 |
| 426 | [51] | AEDC | 1960 | Air | 328 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.3 | 0.5 | 9.1 | 13.0 | 13.0 | 718 |
| 427 | [51] | AEDC | 1960 | Air | 327 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.5 | 0.5 | 9.1 | 13.3 | 13.2 | 664 |
| 428 | [51] | AEDC | 1960 | Air | 327 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.5 | 0.5 | 9.1 | 13.2 | 13.2 | 1570 |
| 429 | [51] | AEDC | 1960 | Air | 327 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 1.0 | 0.5 | 9.1 | 13.9 | 13.9 | 1170 |
| 430 | [51] | AEDC | 1960 | Air | 327 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 1.3 | 0.5 | 9.1 | 13.6 | 13.6 | 1330 |
| 431 | [51] | AEDC | 1960 | Air | 327 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 2.0 | 0.5 | 9.1 | 13.2 | 13.2 | 2080 |
| 432 | [51] | AEDC | 1960 | Air | 329 | CON | 3.20 | 0.14 | 10.8 | 18 | 3c | 22.8 | 4.89 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 6.0 | 0.5 | 9.1 | 13.3 | 13.3 | 6070 |
| 433 | [51] | AEDC | 1960 | Air | 306 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 15.4 | 15.4 | 522 |
| 434 | [51] | AEDC | 1960 | Air | 308 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.5 | 0.4 | 9.1 | 16.2 | 16.2 | 213 |
| 435 | [51] | AEDC | 1960 | Air | 304 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.6 | 0.4 | 9.1 | 17.0 | 16.9 | 207 |
| 436 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 17.6 | 17.6 | 218 |
| 437 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 17.8 | 17.8 | 218 |
| 438 | [51] | AEDC | 1960 | Air | 311 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.3 | 0.4 | 9.1 | 16.9 | 16.9 | 223 |
| 439 | [51] | AEDC | 1960 | Air | 313 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.6 | 0.4 | 9.1 | 16.6 | 16.6 | 221 |
| 440 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.8 | 0.4 | 9.1 | 16.2 | 16.2 | 224 |
| 441 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.9 | 0.4 | 9.1 | 16.3 | 16.3 | 224 |
| 442 | [51] | AEDC | 1960 | Air | 309 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.0 | 0.4 | 9.1 | 16.4 | 16.4 | 213 |
| 443 | [51] | AEDC | 1960 | Air | 316 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.1 | 0.4 | 9.1 | 17.1 | 16.6 | 224 |
| 444 | [51] | AEDC | 1960 | Air | 314 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.3 | 0.4 | 9.1 | 17.2 | 16.9 | 223 |
| 445 | [51] | AEDC | 1960 | Air | 318 | CON | 3.20 | 0.27 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 3.0 | 0.4 | 9.1 | 17.0 | 19.3 | 225 |
| 446 | [51] | AEDC | 1960 | Air | 320 | CON | 3.20 | 0.28 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 3.5 | 0.4 | 9.1 | 17.1 | 19.2 | 223 |
| 447 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 17.9 | 17.9 | 529 |
| 448 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 0.8 | 0.4 | 9.1 | 18.3 | 18.3 | 430 |
| 449 | [51] | AEDC | 1960 | Air | 318 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 1.0 | 0.4 | 9.1 | 18.9 | 18.9 | 430 |
| 450 | [51] | AEDC | 1960 | Air | 318 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.0 | 0.4 | 9.1 | 16.5 | 16.5 | 430 |
| 451 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.1 | 0.4 | 9.1 | 16.7 | 16.4 | 430 |
| 452 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.3 | 0.4 | 9.1 | 17.2 | 15.7 | 431 |
| 453 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.5 | 0.4 | 9.1 | 17.5 | 16.0 | 431 |
| 454 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 2.6 | 0.4 | 9.1 | 18.0 | 16.5 | 431 |
| 455 | [51] | AEDC | 1960 | Air | 320 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 3.0 | 0.4 | 9.1 | 19.0 | 18.3 | 430 |
| 456 | [51] | AEDC | 1960 | Air | 320 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 3.5 | 0.4 | 9.1 | 19.2 | 19.0 | 430 |
| 457 | [51] | AEDC | 1960 | Air | 319 | CON | 3.20 | 0.14 | 10.8 | 18 | 4a | 22.8 | 4.89 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 4.5 | 0.4 | 9.1 | 23.1 | 16.9 | 432 |
| 458 | [51] | AEDC | 1960 | Air | 300 | CON | 2.11 | 0.28 | 25 | 18 | 1a | 52.5 | 5.98 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.0 | 0.4 | 9.1 | 32.4 | 32.4 | 164 |
| 459 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 1a | 52.5 | 5.98 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.3 | 0.4 | 9.1 | 36.6 | 35.3 | 148 |
| 460 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.28 | 25 | 18 | 1a | 52.5 | 5.98 | 0.65 | 1.37 | 1.5 | 6.0 | 0 | 0.0 | 0.7 | 0.4 | 9.1 | 36.8 | 35.5 | 147 |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | | |
|-----|------|--------|------|----------------------|----------------|------|-----------------|---------------------|-------------------------|------------------------|------|-------------------------|-----------------|-------------------------|-------------------------|-------------------------|---------------|---------------|----------------|-------------------------|-------------------------|----------------------|------------------------|------------------------------------|-------|-------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | Name | $\frac{A_{DI}}{A_{NT}}$ | M _{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | θ_{DI} | θ_{DT} | θ_{SUB} | $\frac{L_{DI}}{D_{DI}}$ | $\frac{L_{DT}}{D_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{P_0}{P_{BACK}}$ | $\frac{P_{CELL}}{P_0} \times 10^5$ | Start | Unst. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 490 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.27 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 2.3 | 0.3 | 9.1 | 4.07 | 4.07 | 107 | |
| 491 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.27 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 2.3 | 0.3 | 9.1 | 4.20 | 4.18 | 107 | |
| 492 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.27 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 3.0 | 0.3 | 9.1 | 4.13 | 4.13 | 104 | |
| 493 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.27 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 4.0 | 0.3 | 9.1 | 4.15 | 4.15 | 104 | |
| 494 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.27 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 6.0 | 0.3 | 9.1 | 4.27 | 4.27 | 105 | |
| 495 | [51] | AEDC | 1960 | Air | 296 | CON | 2.11 | 0.18 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 4.27 | 4.08 | 151 | |
| 496 | [51] | AEDC | 1960 | Air | 296 | CON | 2.11 | 0.18 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 4.29 | 4.10 | 150 | |
| 497 | [51] | AEDC | 1960 | Air | 296 | CON | 2.11 | 0.18 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 4.03 | 4.03 | 150 | |
| 498 | [51] | AEDC | 1960 | Air | 296 | CON | 2.11 | 0.18 | 25 | 18 | 2a | 52.5 | 5.98 | 0.80 | 1.68 | 1.3 | 12.0 | 0 | 0.0 | 4.0 | 0.3 | 9.1 | 4.20 | 4.20 | 150 | |
| 499 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.0 | 0.3 | 9.1 | 27.6 | 27.6 | 288 | |
| 500 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 33.3 | 33.3 | 215 | |
| 501 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.7 | 0.3 | 9.1 | 35.7 | 35.7 | 171 | |
| 502 | [51] | AEDC | 1960 | Air | 307 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.8 | 0.3 | 9.1 | 36.9 | 36.9 | 123 | |
| 503 | [51] | AEDC | 1960 | Air | 308 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 35.6 | 34.7 | 123 | |
| 504 | [51] | AEDC | 1960 | Air | 308 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 3.0 | 0.3 | 9.1 | 39.2 | 39.2 | 122 | |
| 505 | [51] | AEDC | 1960 | Air | 308 | CON | 2.11 | 0.27 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 50.8 | 50.8 | 127 | |
| 506 | [51] | AEDC | 1960 | Air | 304 | CON | 2.11 | 0.32 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.0 | 0.3 | 9.1 | 39.7 | 39.7 | 98.9 | |
| 507 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.3 | 0.3 | 9.1 | 29.9 | 24.6 | 418 | |
| 508 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 0.7 | 0.3 | 9.1 | 30.0 | 30.0 | 335 | |
| 509 | [51] | AEDC | 1960 | Air | 318 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 1.0 | 0.3 | 9.1 | 31.1 | 31.1 | 577 | |
| 510 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 38.2 | 38.2 | 186 | |
| 511 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 2.0 | 0.3 | 9.1 | 35.2 | 34.1 | 158 | |
| 512 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.16 | 25 | 18 | 2b | 52.5 | 5.98 | 0.57 | 1.19 | 1.8 | 12.0 | 0 | 0.0 | 3.0 | 0.3 | 9.1 | 38.2 | 33.0 | 158 | |
| 513 | [51] | AEDC | 1960 | Air | 305 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.7 | 0.7 | 9.1 | 36.0 | 35.7 | 155 | |
| 514 | [51] | AEDC | 1960 | Air | 305 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 0.7 | 9.1 | 33.3 | 33.1 | 138 | |
| 515 | [51] | AEDC | 1960 | Air | 305 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 0.7 | 9.1 | 33.6 | 33.3 | 138 | |
| 516 | [51] | AEDC | 1960 | Air | 305 | CON | 2.11 | 0.21 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 0.7 | 9.1 | 33.9 | 33.8 | 136 | |
| 517 | [51] | AEDC | 1960 | Air | 306 | CON | 2.11 | 0.27 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.9 | 0.7 | 9.1 | 35.0 | 34.6 | 130 | |
| 518 | [51] | AEDC | 1960 | Air | 301 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 0.7 | 9.1 | 35.1 | 34.7 | 136 | |
| 519 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.1 | 0.7 | 9.1 | 35.1 | 34.7 | 136 | |
| 520 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.2 | 0.7 | 9.1 | 35.1 | 34.7 | 137 | |
| 521 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 0.7 | 9.1 | 34.8 | 34.5 | 136 | |
| 522 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 0.7 | 9.1 | 35.1 | 34.1 | 137 | |
| 523 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.28 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.4 | 0.7 | 9.1 | 36.9 | 34.1 | 136 | |
| 524 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.5 | 0.7 | 9.1 | 46.7 | 34.0 | 137 | |
| 525 | [51] | AEDC | 1960 | Air | 304 | CON | 2.11 | 0.14 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.2 | 0.7 | 9.1 | 33.1 | 32.9 | 191 | |
| 526 | [51] | AEDC | 1960 | Air | 306 | CON | 2.11 | 0.14 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 0.7 | 9.1 | 42.0 | 41.5 | 185 | |
| 527 | [51] | AEDC | 1960 | Air | 304 | CON | 2.11 | 0.14 | 25 | 18 | 3a | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 2.0 | 0.7 | 9.1 | 37.3 | 33.3 | 185 | |
| 528 | [51] | AEDC | 1960 | Air | 298 | CON | 2.11 | 0.28 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.6 | 8.0 | 9.1 | 25.9 | 25.9 | 142 | |
| 529 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.27 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.7 | 8.0 | 9.1 | 27.0 | 26.7 | 107 | |
| 530 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.28 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 0.7 | 8.0 | 9.1 | 26.8 | 26.7 | 106 | |
| 531 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.27 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 8.0 | 9.1 | 25.4 | 25.3 | 102 | |
| 532 | [51] | AEDC | 1960 | Air | 300 | CON | 2.11 | 0.27 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 8.0 | 9.1 | 24.4 | 24.3 | 102 | |
| 533 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.27 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 8.0 | 9.1 | 24.4 | 24.3 | 102 | |
| 534 | [51] | AEDC | 1960 | Air | 300 | CON | 2.11 | 0.14 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 8.0 | 9.1 | 24.8 | 24.6 | 180 | |
| 535 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.14 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 8.0 | 9.1 | 24.7 | 24.7 | 156 | |
| 536 | [51] | AEDC | 1960 | Air | 299 | CON | 2.11 | 0.14 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 8.0 | 9.1 | 23.8 | 23.6 | 151 | |
| 537 | [51] | AEDC | 1960 | Air | 300 | CON | 2.11 | 0.14 | 25 | 18 | 3b | 52.5 | 5.98 | 0.50 | 1.05 | 2.0 | 12.0 | 0 | 0.0 | 2.0 | 8.0 | 9.1 | 23.3 | 21.8 | 151 | |
| 538 | [51] | AEDC | 1960 | Air | 301 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.0 | 0.5 | 9.1 | 28.4 | 28.2 | 242 | |
| 539 | [51] | AEDC | 1960 | Air | 301 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.2 | 0.5 | 9.1 | 28.6 | 28.4 | 207 | |
| 540 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.6 | 0.5 | 9.1 | 30.8 | 30.8 | 152 | |
| 541 | [51] | AEDC | 1960 | Air | 302 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.7 | 0.5 | 9.1 | 31.5 | 31.5 | 133 | |
| 542 | [51] | AEDC | 1960 | Air | 303 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 0.7 | 0.5 | 9.1 | 26.2 | 26.2 | 562 | |
| 543 | [51] | AEDC | 1960 | Air | 308 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 1.0 | 0.5 | 9.1 | 28.5 | 28.5 | 523 | |
| 544 | [51] | AEDC | 1960 | Air | 307 | CON | 2.11 | 0.27 | 25 | 18 | 3c | 52.5 | 5.98 | 0.40 | 0.84 | 2.5 | 12.0 | 0 | 0.0 | 2.0 | 0.5 | 9.1 | 29.2 | 29.2 | 1150 | |
| 545 | [51] | AEDC | 1960 | Air | 306 | CON | 2.11 | 0.27 | | | | | | | | | | | | | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|------|----------|------|----------------------|----------------|-------|-----------------|---------------------|------------------------------------|------------------------|------|------------------------------------|-----------------|------------------------------------|------------------------------------|------------------------------------|-----------------|-----------------|------------------|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|--|------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | A _{NE} A _{NT} | θ _{NE} | Name | A _{DI} A _{NT} | M _{DI} | A _{DT} A _{DI} | A _{DT} A _{NE} | A _{DE} A _{DT} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} D _{DI} | L _{DT} D _{DT} | L _D D _{DT} | P ₀ P _{BACK} | (P _{CELL} P ₀) × 10 ⁵ | |
| | | | | [K] | [cm] | [MPa] | [deg] | | | < [deg] > | | | | | | | | | | | | | Start | Unst. | |
| 573 | [51] | AEDC | 1960 | Air | 297 | CON | 2.11 | 0.14 | 25 | 18 | 4a | 52.5 | 5.98 | 0.65 | 1.37 | 1.5 | 18.0 | 0 | 0.0 | 5.2 | 0.4 | 9.1 | 43.3 | 43.3 | 153 |
| 574 | [51] | AEDC | 1960 | Air | 299 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.0 | 8.0 | 9.1 | 18.3 | 18.3 | 116 |
| 575 | [51] | AEDC | 1960 | Air | 299 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.5 | 8.0 | 9.1 | 19.3 | 19.3 | 56.2 |
| 576 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.6 | 8.0 | 9.1 | 19.7 | 19.7 | 36.3 |
| 577 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.7 | 8.0 | 9.1 | 19.6 | 19.6 | 36.3 |
| 578 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 8.0 | 9.1 | 19.7 | 19.7 | 36.4 |
| 579 | [51] | AEDC | 1960 | Air | 298 | TOP | 2.29 | 0.27 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 8.0 | 9.1 | 19.9 | 19.9 | 36.4 |
| 580 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.28 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 8.0 | 9.1 | 20.7 | 20.7 | 36.4 |
| 581 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.27 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.7 | 8.0 | 9.1 | 22.5 | 22.5 | 36.4 |
| 582 | [51] | AEDC | 1960 | Air | 299 | TOP | 2.29 | 0.27 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 2.0 | 8.0 | 9.1 | 28.8 | 23.9 | 36.5 |
| 583 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.3 | 8.0 | 9.1 | 18.9 | 18.9 | 102 |
| 584 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.6 | 8.0 | 9.1 | 20.0 | 20.0 | 40.0 |
| 585 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 0.8 | 8.0 | 9.1 | 20.0 | 20.0 | 40.0 |
| 586 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.0 | 8.0 | 9.1 | 20.2 | 20.2 | 40.0 |
| 587 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.2 | 8.0 | 9.1 | 20.4 | 20.4 | 40.0 |
| 588 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 1.3 | 8.0 | 9.1 | 25.4 | 21.2 | 40.0 |
| 589 | [51] | AEDC | 1960 | Air | 300 | TOP | 2.29 | 0.14 | 23.7 | 0.0 | 3b | 44.7 | 5.76 | 0.50 | 0.94 | 2.0 | 12.0 | 0 | 0.0 | 2.0 | 8.0 | 9.1 | 31.5 | 24.0 | 40.9 |
| 590 | [6] | NASA JPL | 1960 | N2 | NR | TOC | 1.40 | 1.03 | 20.3 | 12.8 | - | 28.8 | 5.18 | 0.51 | 0.65 | 4.0 | 5.0 | 0 | 10.0 | 0.1 | 10.0 | 13.1 | 15.7 | 10.1 | NR |
| 591 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | 0.0 | 0 | NR | - | 5.8 | NR | 23.9 | 23.9 | 62.9 |
| 592 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | 0.0 | 0 | NR | - | 7.3 | NR | 28.6 | 28.6 | 52.4 |
| 593 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | 0.0 | 0 | NR | - | 8.7 | NR | 27.6 | 27.6 | 54.3 |
| 594 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | 0.0 | 0 | NR | - | 9.0 | NR | 28.4 | 28.4 | 52.7 |
| 595 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | -7.0 | 0 | NR | - | 5.8 | NR | 23.0 | 23.0 | 95.7 |
| 596 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | -7.0 | 0 | NR | - | 7.2 | NR | 20.7 | 20.7 | 106 |
| 597 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | -7.0 | 0 | NR | - | 8.7 | NR | 20.6 | 20.6 | 107 |
| 598 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | -7.0 | 0 | NR | - | 9.0 | NR | 21.3 | 21.3 | 103 |
| 599 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 30.5 | 5.25 | 1.00 | 5.20 | NR | -7.0 | 0 | NR | - | 9.0 | NR | 19.7 | 19.7 | 111 |
| 600 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | 0.0 | 0 | NR | - | 5.3 | NR | 21.9 | 21.9 | 80.1 |
| 601 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | 0.0 | 0 | NR | - | 7.1 | NR | 19.1 | 19.1 | 91.8 |
| 602 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | 0.0 | 0 | NR | - | 8.8 | NR | 19.6 | 19.6 | 89.2 |
| 603 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | 0.0 | 0 | NR | - | 10.9 | NR | 18.5 | 18.5 | 94.5 |
| 604 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -7.0 | 0 | NR | - | 5.2 | NR | 17.2 | 17.2 | 125 |
| 605 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -7.0 | 0 | NR | - | 7.0 | NR | 16.7 | 16.7 | 129 |
| 606 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -7.0 | 0 | NR | - | 8.9 | NR | 16.1 | 16.1 | 134 |
| 607 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -7.0 | 0 | NR | - | 11.0 | NR | 15.9 | 15.9 | 135 |
| 608 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -11.0 | 0 | NR | - | 5.3 | NR | 21.2 | 21.2 | 85.1 |
| 609 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 20.3 | 4.74 | 1.00 | 3.46 | NR | -11.0 | 0 | NR | - | 5.3 | NR | 19.7 | 19.7 | 91.5 |
| 610 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | 0.0 | 0 | NR | - | 6.9 | NR | 12.2 | 12.2 | 197 |
| 611 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | 0.0 | 0 | NR | - | 9.1 | NR | 11.1 | 11.1 | 217 |
| 612 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | 0.0 | 0 | NR | - | 11.4 | NR | 12.1 | 12.1 | 198 |
| 613 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | 0.0 | 0 | NR | - | 14.0 | NR | 11.8 | 11.8 | 203 |
| 614 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | -7.0 | 0 | NR | - | 9.1 | NR | 11.3 | 11.3 | 182 |
| 615 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | -7.0 | 0 | NR | - | 11.4 | NR | 11.6 | 11.6 | 177 |
| 616 | [52] | Thiokol | 1960 | N2 | AMB | CON | 0.64 | 0.31 | 5.86 | 8.2 | - | 12.3 | 4.16 | 1.00 | 2.10 | NR | -7.0 | 0 | NR | - | 14.0 | NR | 11.4 | 11.4 | 180 |
| 617 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | S1 | 41.5 | 5.66 | 0.64 | 0.66 | 9.1 | 5.6 | 0.5 | 5.10 | 0.0 | 6.7 | NR | 22.6 | 22.6 | NR |
| 618 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | S2 | 41.5 | 5.66 | 0.64 | 0.66 | 9.1 | 5.6 | 0.5 | 5.10 | 0.3 | 6.7 | NR | 22.4 | 22.4 | NR |
| 619 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | S3 | 41.5 | 5.66 | 0.64 | 0.66 | 9.1 | 5.6 | 0.5 | 5.10 | 0.0 | 10.1 | NR | 22.0 | 20.4 | NR |
| 620 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | S4 | 41.5 | 5.66 | 0.64 | 0.66 | 9.9 | 5.6 | 0.5 | 5.10 | 0.3 | 10.1 | NR | 22.2 | 19.9 | NR |
| 621 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | S6 | 41.5 | 5.66 | 0.58 | 0.61 | 9.9 | 5.6 | 0.5 | 5.10 | 0.3 | 6.7 | NR | 21.7 | 21.7 | NR |
| 622 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | - | 59.5 | 6.16 | 0.76 | 0.79 | 9.9 | 5.6 | 0.5 | 5.10 | 0.0 | 6.7 | NR | 25.2 | NR | NR |
| 623 | [9] | P&W | 1960 | N2 | AMB | TOP | 1.27 | NR | 4.0 | 9 | - | 59.5 | 6.16 | 0.76 | 0.79 | 9.9 | 5.6 | 0.5 | 5.10 | 0.3 | 6.7 | NR | 25.6 | NR | NR |
| 624 | [5] | EAFB | 1960 | N2 | 270 | CON | 1.52 | 7.00 | 4.2 | 15 | - | 84.0 | 3.73 | 1.00 | 2.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 7.5 | 7.5 | 800 |
| 625 | [5] | EAFB | 1960 | N2 | 270 | CON | 1.52 | 7.00 | 4.2 | 15 | - | 16.8 | 4.52 | 1.00 | 4.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 14.5 | 14.5 | 352 |
| 626 | [5] | EAFB | 1960 | N2 | 270 | CON | 1.52 | 7.00 | 4.2 | 15 | - | 25.2 | 5.01 | 1.00 | 6.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 21.0 | 21.0 | 236 |
| 627 | [5] | EAFB | 1960 | N2 | 270 | CON | 1.52 | 7.00 | 4.2 | 15 | - | 33.6 | 5.38 | 1.00 | 8.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 27.4 | 27.4 | 181 |
| 628 | [5] | EAFB | 1960 | N2 | 270 | CON | 1.52 | 7.00 | 4.2 | 15 | - | 42.0 | 5.67 | 1.00 | 10.0 | - | 0.0 | 0 | - | - | 8.2+ | NR | 36.5 | 36.5 | 14.0 |
| 629 | [5] | EAFB | 1960 | N2 | 270 | TOP | 1.52 | 7.00 | 4.2 | 8.5 | - | 4.33 | 3.02 | 1.00 | 1.03 | - | 0.0 | 0 | - | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|------|-----------|------|----------------------|----------------|-------|-----------------|---------------------|-------------------------|------------------------|------|-------------------------|-----------------|-------------------------|-------------------------|-------------------------|---------------|---------------|----------------|-------------------------|-------------------------|----------------------|------------------------|------------------------------------|-------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | Name | $\frac{A_{DI}}{A_{NI}}$ | M _{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | θ_{DI} | θ_{DT} | θ_{SUB} | $\frac{L_{DI}}{D_{DI}}$ | $\frac{L_{DT}}{D_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{P_0}{P_{BACK}}$ | $\frac{P_{CELL}}{P_0} \times 10^5$ | Start |
| | | | | [K] | [cm] | [MPa] | [deg] | < [deg] > | | | | | | | | | | | | | | | | | |
| 656 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.94 | 7.00 | 11.0 | 6.0 | - | 15.4 | 4.41 | 1.00 | 1.40 | - | 0.0 | 0 | - | - | 8.2+ | NR | 13.0 | 13.0 | 69.2 |
| 657 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.94 | 7.00 | 11.0 | 6.0 | - | 22.1 | 4.85 | 1.00 | 2.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 20.0 | 20.0 | 30.0 |
| 658 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.94 | 7.00 | 11.0 | 6.0 | - | 33.1 | 5.36 | 1.00 | 3.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 34.0 | 34.0 | 19.1 |
| 659 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.94 | 7.00 | 11.0 | 6.0 | - | 66.2 | 6.31 | 1.00 | 6.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 55.5 | 55.5 | 16.2 |
| 660 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 26.8 | 5.09 | 1.00 | 1.03 | - | 0.0 | 0 | - | - | 8.2+ | NR | 20.4 | 20.4 | 152 |
| 661 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 28.6 | 5.17 | 1.00 | 1.10 | - | 0.0 | 0 | - | - | 8.2+ | NR | 22.8 | 22.8 | 105 |
| 662 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 31.2 | 5.28 | 1.00 | 1.20 | - | 0.0 | 0 | - | - | 8.2+ | NR | 25.6 | 25.6 | 64.5 |
| 663 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 36.4 | 5.48 | 1.00 | 1.40 | - | 0.0 | 0 | - | - | 8.2+ | NR | 30.0 | 30.0 | 40.0 |
| 664 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 41.6 | 5.66 | 1.00 | 1.60 | - | 0.0 | 0 | - | - | 8.2+ | NR | 35.6 | 35.6 | 28.1 |
| 665 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 52.0 | 5.97 | 1.00 | 2.00 | - | 0.0 | 0 | - | - | 8.2+ | NR | 41.6 | 41.6 | 19.2 |
| 666 | [51] | EAFB | 1960 | N2 | 270 | TOP | 0.61 | 7.00 | 26.0 | 6.0 | - | 72.8 | 6.45 | 1.00 | 2.80 | - | 0.0 | 0 | - | - | 8.2+ | NR | 56.4 | 56.4 | 13.3 |
| 667 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 6.73 | 0.48 | 5.5 | 19.5 | - | 9.30 | 3.84 | 1.00 | 1.69 | - | - | 0 | - | - | 19.0 | 19.0 | 8.1 | 8.1 | NR |
| 668 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 6.73 | 0.48 | 5.5 | 19.5 | - | 14.4 | 4.34 | 1.00 | 2.61 | - | - | 0 | - | - | 15.0 | 15.0 | 12.8 | 12.8 | NR |
| 669 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 6.73 | 0.48 | 5.5 | 19.5 | - | 20.5 | 4.76 | 1.00 | 3.73 | - | - | 0 | - | - | 12.5 | 12.5 | 17.7 | 17.7 | NR |
| 670 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.45 | 0.48 | 11.7 | 15 | - | 21.2 | 4.80 | 1.00 | 1.81 | - | - | 0 | - | - | 4.0 | 4.0 | 19.4 | 16.9 | NR |
| 671 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.45 | 0.48 | 11.7 | 15 | - | 21.2 | 4.80 | 1.00 | 1.81 | - | - | 0 | - | - | 7.4 | 7.4 | 17.1 | 17.1 | NR |
| 672 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.45 | 0.48 | 11.7 | 15 | - | 21.2 | 4.80 | 1.00 | 1.81 | - | - | 0 | - | - | 19.0 | 19.0 | 18.0 | 18.0 | NR |
| 673 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.45 | 0.48 | 11.7 | 15 | - | 33.8 | 5.39 | 1.00 | 2.89 | - | - | 0 | - | - | 15.0 | 15.0 | 27.6 | 27.6 | NR |
| 674 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.45 | 0.48 | 11.7 | 15 | - | 47.8 | 5.85 | 1.00 | 4.09 | - | - | 0 | - | - | 12.5 | 12.5 | 37.9 | 37.9 | NR |
| 675 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 2.0 | 2.0 | 4.75 | 35.5 | NR |
| 676 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 3.0 | 3.0 | 35.0 | 30.7 | NR |
| 677 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 4.0 | 4.0 | 27.2 | 26.1 | NR |
| 678 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 6.0 | 6.0 | 23.0 | 23.0 | NR |
| 679 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | 2.0 | - | 0 | NR | - | 6.0 | NR | 21.9 | 21.9 | NR |
| 680 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 12.0 | 12.0 | 23.3 | 23.3 | 21.0 |
| 681 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 18.0 | 18.0 | 23.6 | 23.6 | NR |
| 682 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 32.8 | 5.35 | 1.00 | 1.31 | - | - | 0 | - | - | 6.0 | 6.0 | 27.3 | 27.3 | NR |
| 683 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 32.8 | 5.35 | 1.00 | 1.31 | 2.0 | - | 0 | NR | - | 6.0 | NR | 25.4 | 25.4 | NR |
| 684 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 46.1 | 5.80 | 1.00 | 1.84 | - | - | 0 | - | - | 14.0 | 14.0 | 36.4 | 36.4 | NR |
| 685 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 50.8 | 5.94 | 1.00 | 2.03 | - | - | 0 | - | - | 6.0 | 6.0 | 39.6 | 39.6 | NR |
| 686 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 50.8 | 5.94 | 1.00 | 2.03 | 2.0 | - | 0 | NR | - | 6.0 | NR | 37.4 | 37.4 | NR |
| 687 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 64.1 | 6.27 | 1.00 | 2.56 | - | - | 0 | - | - | 10.0 | 10.0 | 48.8 | 48.8 | NR |
| 688 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.17 | 0.48 | 50 | 15 | - | 50.8 | 5.94 | 1.00 | 1.02 | - | - | 0 | - | - | 6.0 | 6.0 | 38.8 | 38.8 | NR |
| 689 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.17 | 0.48 | 50 | 15 | - | 50.8 | 5.94 | 1.00 | 1.02 | 2.0 | - | 0 | NR | - | 6.0 | NR | 35.8 | 35.8 | NR |
| 690 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.17 | 0.48 | 50 | 15 | - | 53.5 | 6.01 | 1.00 | 1.07 | - | - | 0 | - | - | 4.0 | 4.0 | 46.5 | 42.0 | NR |
| 691 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.17 | 0.48 | 50 | 15 | - | 53.5 | 6.01 | 1.00 | 1.07 | - | - | 0 | - | - | 6.0 | 6.0 | 40.3 | 40.3 | NR |
| 692 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 4.17 | 0.48 | 50 | 15 | - | 53.5 | 6.01 | 1.00 | 1.07 | - | - | 0 | - | - | 8.0 | 8.0 | 39.9 | 39.9 | NR |
| 693 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 2.0 | 2.0 | 45.0 | 42.5 | NR |
| 694 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 4.0 | 4.0 | 31.0 | 30.3 | NR |
| 695 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 6.0 | 6.0 | 22.8 | 22.8 | NR |
| 696 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 10.0 | 10.0 | 22.5 | 22.5 | NR |
| 697 | [7] | NASA LeRC | 1960 | Air | 294 | TOP | 3.81 | 0.48 | 25 | 9.8 | - | 28.9 | 5.18 | 1.00 | 1.16 | - | - | 0 | - | - | 6.5 | 6.5 | 22.9 | 22.9 | NR |
| 698 | [7] | NASA LeRC | 1960 | Air | 294 | TOP | 3.81 | 0.48 | 25 | 9.8 | - | 50.9 | 5.94 | 1.00 | 2.04 | - | - | 0 | - | - | 6.5 | 6.5 | 41.8 | 41.8 | NR |
| 699 | [7] | NASA LeRC | 1960 | Air | 294 | TOP | 3.92 | 0.48 | 27 | 0.0 | - | 43.5 | 5.72 | 1.00 | 1.59 | - | - | 0 | - | - | 10.0 | 10.0 | 37.0 | 37.0 | NR |
| 700 | [7] | NASA LeRC | 1960 | Air | 700 | TOC | 8.85 | 0.48 | 63 | 0.0 | - | 69.3 | 6.38 | 1.00 | 1.10 | - | - | 0 | - | - | 8.0 | 8.0 | 55.0 | 55.0 | NR |
| 701 | [7] | NASA LeRC | 1960 | Air | 700 | TOC | 8.85 | 0.48 | 63 | 0.0 | - | 101 | 6.95 | 1.00 | 1.60 | - | - | 0 | - | - | 10.0 | 10.0 | 71.1 | 71.1 | NR |
| 702 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 0.3 | 4.5 | 28.5 | 28.5 | NR |
| 703 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 1.1 | 5.1 | 23.0 | 23.0 | NR |
| 704 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 2.1 | 5.9 | 22.4 | 22.4 | NR |
| 705 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 3.1 | 6.6 | 19.1 | 19.1 | NR |
| 706 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 4.1 | 7.5 | 16.0 | 16.0 | NR |
| 707 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 9.9 | 11.7 | 14.1 | 12.8 | NR |
| 708 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.65 | 0.75 | 1.3 | 3.8 | 0 | 3.8 | 0.5 | 3.0 | NR | 19.1 | 19.1 | NR |
| 709 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 4.0 | NR | 16.1 | 16.1 | NR |
| 710 | [7] | NASA LeRC | 1960 | Air | 294 | CON | 3.81 | 0.48 | 25 | 15 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 1.0 | 4.0 | NR | 18.5 | 18.5 | NR |
| 711 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.1 | 9.8 | NR | 14.5 | 14.5 | NR |
| 712 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.3 | 9.8 | NR | 14.5 | 14.5 | NR |
| 713 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 0.5 | 9.8 | NR | 14.9 | 14.9 | NR |
| 714 | [7] | NASA LeRC | 1960 | Air | 294 | TIC | 3.81 | 0.48 | 25 | 9.5 | - | 28.9 | 5.18 | 0.55 | 0.64 | 1.6 | 3.8 | 0 | 3.8 | 1.0 | 9.8 | NR | 16.1 | 16.1 | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | | |
|-----|------|-----------|------|----------------------|----------------|---------|-----------------|---------------------|-------------------------|------------------------|------|-------------------------|-----------------|-------------------------|-------------------------|-------------------------|---------------|---------------|----------------|-------------------------|-------------------------|----------------------|------------------------|------------------------------------|------|----|
| | | | | Gas | T ₀ | Type | D _{nr} | Ref. P ₀ | $\frac{A_{NE}}{A_{NT}}$ | θ_{NE} | Name | $\frac{A_{DI}}{A_{NI}}$ | M _{DI} | $\frac{A_{DT}}{A_{DI}}$ | $\frac{A_{DT}}{A_{NE}}$ | $\frac{A_{DE}}{A_{DT}}$ | θ_{DI} | θ_{DT} | θ_{SUB} | $\frac{L_{DI}}{D_{DI}}$ | $\frac{L_{DT}}{D_{DT}}$ | $\frac{L_D}{D_{DT}}$ | $\frac{P_0}{P_{BACK}}$ | $\frac{P_{CELL}}{P_0} \times 10^5$ | | |
| | | | | [K] | [cm] | [MPa] | [deg] | | | | | | | | | | | | | | | | Start | Unst. | | |
| 739 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 51.0 | 5.94 | 1.00 | 2.04 | 2.0 | - | 0 | 8.0 | - | 5.5 | NR | 42.4 | 42.4 | NR | |
| 740 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 51.0 | 5.94 | 1.00 | 2.04 | 2.0 | - | 0 | 8.0 | - | 7.4 | NR | 38.1 | 38.1 | NR | |
| 741 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 51.0 | 5.94 | 1.00 | 2.04 | 2.0 | - | 0 | 8.0 | - | 9.7 | NR | 36.5 | 36.5 | NR | |
| 742 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 51.0 | 5.94 | 1.00 | 2.04 | 2.0 | - | 0 | 8.0 | - | 10.5 | NR | 37.5 | 37.5 | NR | |
| 743 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 50 | 15 | - | 51.0 | 5.94 | 1.00 | 1.02 | - | - | 0 | - | - | - | NR | 38.0 | 38.0 | NR | |
| 744 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 50 | 15 | - | 51.0 | 5.94 | 1.00 | 1.02 | 2.0 | - | 0 | 8.0 | - | - | NR | 35.5 | 35.5 | NR | |
| 745 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 28.0 | 5.14 | 1.00 | 1.12 | - | - | 0 | - | - | 4.0 | NR | 28.0 | 28.0 | NR | |
| 746 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 28.0 | 5.14 | 1.00 | 1.12 | - | - | 0 | - | - | 6.0 | NR | 24.5 | 24.5 | NR | |
| 747 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 28.0 | 5.14 | 1.00 | 1.12 | - | - | 0 | - | - | 9.3 | NR | 23.5 | 23.5 | NR | |
| 748 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 33.0 | 5.35 | 1.00 | 1.32 | - | - | 0 | - | - | 4.0 | NR | 32.5 | 32.5 | NR | |
| 749 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 33.0 | 5.35 | 1.00 | 1.32 | - | - | 0 | - | - | 6.0 | NR | 28.3 | 28.3 | NR | |
| 750 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 33.0 | 5.35 | 1.00 | 1.32 | - | - | 0 | - | - | 9.3 | NR | 27.8 | 27.8 | NR | |
| 751 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 33.0 | 5.35 | 1.00 | 1.32 | - | - | 0 | - | - | 16.0 | NR | 29.0 | 29.0 | NR | |
| 752 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 51.0 | 5.94 | 1.00 | 2.04 | - | - | 0 | - | - | 4.0 | NR | 47.1 | 47.1 | NR | |
| 753 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 51.0 | 5.94 | 1.00 | 2.04 | - | - | 0 | - | - | 6.0 | NR | 43.1 | 43.1 | NR | |
| 754 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 51.0 | 5.94 | 1.00 | 2.04 | - | - | 0 | - | - | 9.0 | NR | 42.7 | 42.7 | NR | |
| 755 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 0.0 | NR | 24.3 | 24.3 | NR | |
| 756 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 1.5 | NR | 18.5 | 18.5 | NR | |
| 757 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 3.1 | NR | 15.9 | 15.9 | NR | |
| 758 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 6.1 | NR | 15.6 | 12.2 | NR | |
| 759 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 10.2 | NR | 19.5 | 11.3 | NR | |
| 760 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 8.0 | NR | 16.0 | 12.3 | 12.0 | |
| 761 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 2.8 | 41.9 | 36.6 | NR | |
| 762 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 6.9 | 13.6 | 12.6 | NR | |
| 763 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 9.7 | 13.5 | 12.1 | NR | |
| 764 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 1.7 | 28.0 | 27.6 | NR | |
| 765 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 4.6 | 19.6 | 18.0 | NR | |
| 766 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 6.0 | 15.0 | 15.0 | NR | |
| 767 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.47 | 0.56 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 8.7 | 15.2 | 14.2 | NR | |
| 768 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 0.0 | NR | 28.0 | 28.0 | NR | |
| 769 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 1.5 | NR | 20.7 | 20.7 | NR | |
| 770 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 2.9 | NR | 18.2 | 18.2 | NR | |
| 771 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 5.8 | NR | 14.0 | 12.8 | NR | |
| 772 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 9.7 | NR | 11.0 | 12.9 | NR | |
| 773 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 4.6 | 17.5 | 16.4 | NR | |
| 774 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 6.7 | 13.4 | 12.6 | NR | |
| 775 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 6.0 | 0 | 8.0 | 0.2 | NR | 9.5 | 14.2 | 13.5 | NR | |
| 776 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 1.8 | 36.6 | 32.0 | NR | |
| 777 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 3.8 | 19.7 | 19.7 | NR | |
| 778 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 6.0 | 14.5 | 14.5 | NR | |
| 779 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.54 | 0.65 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 8.7 | 16.9 | 15.8 | NR | |
| 780 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 0.0 | NR | 29.6 | 29.6 | NR | |
| 781 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 1.4 | NR | 21.8 | 21.8 | NR | |
| 782 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 2.7 | NR | 18.4 | 18.4 | NR | |
| 783 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 5.5 | NR | 13.6 | 13.6 | NR | |
| 784 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 9.1 | NR | 15.1 | 14.1 | NR | |
| 785 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 1.8 | 39.0 | 26.5 | NR | |
| 786 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 3.8 | 20.6 | 18.0 | NR | |
| 787 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 6.0 | 16.4 | 15.6 | NR | |
| 788 | [53] | NASA LeRC | 1960 | N2 | NR | CON | 0.66 | 4.86 | 25 | 15 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 8.7 | 16.6 | 16.0 | NR | |
| 789 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 0.4 | NR | 23.9 | 23.9 | NR | |
| 790 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 1.4 | NR | 4.5 | 19.8 | 19.8 | NR |
| 791 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 2.8 | NR | 5.5 | 19.6 | 18.4 | NR |
| 792 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 5.5 | NR | 7.7 | 22.0 | 16.7 | NR |
| 793 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 3.0 | 0 | 8.0 | 0.2 | 9.1 | NR | 10.5 | 24.0 | 14.3 | NR |
| 794 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 1.7 | 35.2 | 35.2 | NR | |
| 795 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | NR | 2.1 | 34.7 | 34.7 | NR | |
| 796 | [53] | NASA LeRC | 1960 | N2 | NR | 80° TOP | 0.66 | 4.86 | 25 | 4.0 | - | 30.0 | 5.23 | 0.60 | 0.72 | 2.0 | 15.0 | 0 | 8.0 | 0.2 | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|------|--------|------|----------------------|----------------|------|-----------------|---------------------|----------------------------------|------------------------|------|----------------------------------|-----------------|----------------------------------|----------------------------------|-----------------|-----------------|------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|-----------------------------------|------------------|------|
| | | | | Gas | T ₀ | Type | D _{NT} | Ref. P ₀ | A _{NE} /A _{NT} | θ _{NE} | Name | A _{DI} /A _{NI} | M _{DI} | A _{DT} /A _{DI} | A _{DE} /A _{DE} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} /D _{DI} | L _{DT} /D _{DT} | L _D /D _{DT} | P ₀ /P _{BACK} | P _{CELL} /P ₀ | x10 ⁵ | |
| | | | | | | | | | | | | | | | | | | | | | | | | | [K] |
| 822 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5a | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 1.0 | 0.6 | 9.1 | 88.5 | 85.5 | 29.1 |
| 823 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 0.7 | 8.1 | 9.1 | 69.4 | 69.4 | 47.4 |
| 824 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 0.8 | 8.1 | 9.1 | 73.5 | 73.5 | 29.3 |
| 825 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 8.1 | 9.1 | 71.4 | 71.4 | 29.3 |
| 826 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 1.0 | 8.1 | 9.1 | 70.4 | 70.4 | 29.3 |
| 827 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 1.2 | 8.1 | 9.1 | 69.9 | 69.9 | 29.3 |
| 828 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 1.3 | 8.1 | 9.1 | 68.0 | 68.0 | 30.1 |
| 829 | [54] | AEDC | 1963 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5d | 52.5 | 5.98 | 0.44 | 0.92 | 2.3 | 12.0 | 0 | 0.0 | 1.4 | 8.1 | 9.1 | 68.0 | 68.0 | 29.3 |
| 830 | [54] | AEDC | 1963 | Air | 300 | CON | 2.49 | 0.31 | 18.6 | 18 | 5d | 37.7 | 5.53 | 0.44 | 0.89 | 2.3 | 12.0 | 0 | 0.0 | 0.7 | 8.1 | 9.1 | 54.9 | 54.6 | 51.7 |
| 831 | [54] | AEDC | 1963 | Air | 300 | CON | 2.49 | 0.31 | 18.6 | 18 | 5d | 37.7 | 5.53 | 0.44 | 0.89 | 2.3 | 12.0 | 0 | 0.0 | 0.8 | 8.1 | 9.1 | 54.3 | 54.1 | 37.8 |
| 832 | [54] | AEDC | 1963 | Air | 300 | CON | 2.49 | 0.31 | 18.6 | 18 | 5d | 37.7 | 5.53 | 0.44 | 0.89 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 8.1 | 9.1 | 52.6 | 52.6 | 37.8 |
| 833 | [54] | AEDC | 1963 | Air | 300 | CON | 2.49 | 0.31 | 18.6 | 18 | 5d | 37.7 | 5.53 | 0.44 | 0.89 | 2.3 | 12.0 | 0 | 0.0 | 1.0 | 8.1 | 9.1 | 52.6 | 52.6 | 37.8 |
| 834 | [54] | AEDC | 1963 | Air | 300 | CON | 2.49 | 0.31 | 18.6 | 18 | 5d | 37.7 | 5.53 | 0.44 | 0.89 | 2.3 | 12.0 | 0 | 0.0 | 1.2 | 8.1 | 9.1 | 51.8 | 51.8 | 40.8 |
| 835 | [55] | AEDC | 1963 | Air | 287 | CON | 1.20 | 2.13 | 18 | 18 | 1 | 73.1 | 6.46 | 1.00 | 4.06 | - | - | 0 | - | - | 5.7 | 5.7 | 59.4 | 59.4 | 47.4 |
| 836 | [55] | AEDC | 1963 | Ar | 251 | CON | 1.20 | 1.57 | 18 | 18 | 1 | 73.1 | 10.4 | 1.00 | 4.06 | - | - | 0 | - | - | 5.7 | 5.7 | 70.1 | 70.1 | 72.0 |
| 837 | [55] | AEDC | 1963 | N2 | 256 | CON | 1.20 | 1.69 | 18 | 18 | 1 | 73.1 | 6.46 | 1.00 | 4.06 | - | - | 0 | - | - | 5.7 | 5.7 | 57.2 | 57.2 | 45.0 |
| 838 | [55] | AEDC | 1963 | Air | 261 | CON | 0.77 | 1.94 | 10.8 | 7.6 | 2 | 20.4 | 4.75 | 1.00 | 1.90 | - | - | 0 | - | - | 8.0 | 8.0 | 16.4 | 16.4 | 10.8 |
| 839 | [55] | AEDC | 1963 | Ar | 258 | CON | 0.77 | 1.45 | 10.8 | 7.6 | 2 | 20.4 | 6.61 | 1.00 | 1.90 | - | - | 0 | - | - | 8.0 | 8.0 | 15.5 | 15.5 | 15.9 |
| 840 | [55] | AEDC | 1963 | He | 281 | CON | 0.77 | 1.72 | 10.8 | 7.6 | 2 | 20.4 | 6.61 | 1.00 | 1.90 | - | - | 0 | - | - | 8.0 | 8.0 | 17.5 | 17.5 | 60.7 |
| 841 | [55] | AEDC | 1963 | H2 | 278 | CON | 0.77 | 1.48 | 10.8 | 7.6 | 2 | 20.4 | 4.75 | 1.00 | 1.90 | - | - | 0 | - | - | 8.0 | 8.0 | 15.0 | 15.0 | 68.4 |
| 842 | [55] | AEDC | 1963 | N2 | 271 | CON | 0.77 | 1.45 | 10.8 | 7.6 | 2 | 20.4 | 4.75 | 1.00 | 1.90 | - | - | 0 | - | - | 8.0 | 8.0 | 14.8 | 14.8 | 12.6 |
| 843 | [56] | AEDC | 1963 | Air | 284 | CON | 1.20 | 2.15 | 18 | 18 | 1 | 73.1 | 6.46 | 1.00 | 4.06 | - | - | 0 | - | - | 5.4 | 5.4 | 59.5 | 59.5 | 48.0 |
| 844 | [56] | AEDC | 1963 | Air | 289 | CON | 1.20 | 2.12 | 18 | 18 | 2 | 98.7 | 6.92 | 1.00 | 5.49 | - | - | 0 | - | - | 4.0 | 4.0 | 87.7 | 77.5 | 33.0 |
| 845 | [56] | AEDC | 1963 | Air | 288 | CON | 1.20 | 2.48 | 18 | 18 | 4 | 295 | 8.80 | 1.00 | 16.4 | - | - | 0 | - | - | 3.6 | 3.6 | 285.7 | 285.7 | 9.6 |
| 846 | [56] | AEDC | 1963 | Air | 286 | CON | 1.20 | 2.40 | 18 | 18 | 5 | 453 | 9.65 | 1.00 | 25.1 | - | - | 0 | - | - | 4.4 | 4.4 | 454.5 | 454.5 | 8.2 |
| 847 | [56] | AEDC | 1963 | Air | 289 | CON | 1.20 | 2.40 | 5.0 | 18 | 1 | 73.1 | 6.46 | 1.00 | 1.29 | - | - | 0 | - | - | 5.7 | 5.7 | 64.5 | 64.5 | 71.5 |
| 848 | [56] | AEDC | 1963 | Air | 292 | CON | 1.20 | 2.39 | 5.0 | 18 | 3 | 170 | 7.81 | 1.00 | 34.0 | - | - | 0 | - | - | 3.8 | 3.8 | 153.8 | 153.8 | 32.0 |
| 849 | [56] | AEDC | 1963 | Air | 293 | CON | 1.20 | 2.36 | 5.0 | 18 | 4 | 295 | 8.80 | 1.00 | 59.0 | - | - | 0 | - | - | 3.8 | 3.8 | 285.7 | 285.7 | 17.8 |
| 850 | [56] | AEDC | 1963 | Air | 283 | CON | 2.01 | 2.13 | 3.9 | 10 | 2 | 35.1 | 5.44 | 1.00 | 8.97 | - | - | 0 | - | - | 5.3 | 5.3 | 30.7 | 30.7 | 15.4 |
| 851 | [56] | AEDC | 1963 | Air | 288 | CON | 2.01 | 2.08 | 3.9 | 10 | 3 | 60.4 | 6.18 | 1.00 | 15.4 | - | - | 0 | - | - | 3.8 | 3.8 | 52.6 | 52.6 | 83.0 |
| 852 | [56] | AEDC | 1963 | Air | 283 | CON | 2.01 | 2.10 | 3.1 | 10 | 2 | 35.1 | 5.44 | 1.00 | 11.2 | - | - | 0 | - | - | 5.5 | 5.5 | 31.4 | 31.4 | 188 |
| 853 | [56] | AEDC | 1963 | Air | 285 | CON | 2.01 | 2.13 | 3.1 | 10 | 3 | 60.4 | 6.18 | 1.00 | 19.2 | - | - | 0 | - | - | 3.9 | 3.9 | 56.2 | 56.2 | 102 |
| 854 | [56] | AEDC | 1963 | Air | 282 | CON | 1.90 | 2.09 | 10.5 | 9.0 | 3 | 67.6 | 6.34 | 1.00 | 6.43 | - | - | 0 | - | - | 3.8 | 3.8 | 93.5 | 58.8 | 32.9 |
| 855 | [56] | AEDC | 1963 | Air | 281 | CON | 2.01 | 1.97 | 3.9 | 10 | S3c | 60.4 | 6.18 | 0.65 | 10.0 | - | 15.0 | 0 | - | 0.8 | 4.5 | 5.1 | 62.9 | 62.9 | 87.0 |
| 856 | [56] | AEDC | 1963 | Air | 281 | CON | 2.01 | 1.97 | 3.9 | 10 | S3c | 60.4 | 6.18 | 0.65 | 10.0 | - | 15.0 | 0 | - | 0.8 | 4.5 | 5.1 | 51.0 | 51.0 | NR |
| 857 | [56] | AEDC | 1963 | Air | 284 | CON | 1.90 | 2.12 | 10.5 | 9.0 | S3b | 67.6 | 6.34 | 0.57 | 3.65 | - | 15.0 | 0 | - | 0.8 | 4.6 | 5.4 | 43.7 | 43.7 | 42.6 |
| 858 | [56] | AEDC | 1963 | Air | 282 | CON | 1.90 | 2.12 | 10.5 | 9.0 | S3b | 67.6 | 6.34 | 0.57 | 3.65 | - | 15.0 | 0 | - | 0.8 | 4.6 | 5.4 | 159 | 159 | 44.6 |
| 859 | [56] | AEDC | 1963 | Air | 281 | CON | 1.90 | 2.12 | 10.5 | 9.0 | S3b | 67.6 | 6.34 | 0.57 | 3.65 | - | 15.0 | 0 | - | 1.0 | 4.6 | 5.5 | 42.0 | 42.0 | 27.5 |
| 860 | [56] | AEDC | 1963 | Air | 278 | CON | 1.90 | 2.07 | 10.5 | 9.0 | S3c | 67.6 | 6.34 | 0.65 | 4.17 | - | 15.0 | 0 | - | 0.8 | 4.5 | 5.1 | 185 | 47.4 | 27.5 |
| 861 | [56] | AEDC | 1963 | Air | 278 | CON | 1.90 | 2.05 | 10.5 | 9.0 | S3c | 67.6 | 6.34 | 0.65 | 4.17 | - | 15.0 | 0 | - | 0.8 | 4.5 | 5.1 | 37.6 | 37.6 | 27.5 |
| 862 | [56] | AEDC | 1963 | Air | 278 | CON | 1.90 | 2.05 | 10.5 | 9.0 | S3c | 67.6 | 6.34 | 0.65 | 4.17 | - | 15.0 | 0 | - | 0.0 | 4.5 | 4.9 | 45.0 | 45.0 | 27.5 |
| 863 | [12] | AEDC | 1965 | Air | 300 | TOP | 2.29 | 0.31 | 23.7 | 0.0 | 5d | 128 | 7.33 | 0.44 | 2.37 | 2.3 | 12.0 | 0 | 0.0 | 0.8 | 8.1 | 9.1 | 59.2 | 58.5 | 15.5 |
| 864 | [12] | AEDC | 1965 | Air | 300 | TOP | 2.29 | 0.31 | 23.7 | 0.0 | 5d | 128 | 7.33 | 0.44 | 2.37 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 8.1 | 9.1 | 59.9 | 59.2 | 15.5 |
| 865 | [12] | AEDC | 1965 | Air | 300 | TOP | 2.29 | 0.31 | 23.7 | 0.0 | 5d | 128 | 7.33 | 0.44 | 2.37 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 8.1 | 9.1 | 61.7 | 59.9 | 15.1 |
| 866 | [12] | AEDC | 1965 | Air | 300 | CON | 3.20 | 0.31 | 10.8 | 18 | 6 | 22.7 | 4.88 | 0.58 | 1.21 | 1.7 | 6.0 | 0 | 0.0 | 0.6 | 0.2 | 9.1 | 38.0 | 33.6 | 20.4 |
| 867 | [12] | AEDC | 1965 | Air | 300 | CON | 3.20 | 0.31 | 10.8 | 18 | 6 | 22.7 | 4.88 | 0.58 | 1.21 | 1.7 | 6.0 | 0 | 0.0 | 0.7 | 0.2 | 9.1 | 36.4 | 36.4 | 188 |
| 868 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.32 | 25 | 18 | 6 | 52.3 | 5.98 | 0.58 | 1.21 | 1.7 | 6.0 | 0 | 0.0 | 0.6 | 0.2 | 9.1 | 84.0 | 94.2 | 88.8 |
| 869 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 6 | 52.3 | 5.98 | 0.58 | 1.21 | 1.7 | 6.0 | 0 | 0.0 | 0.8 | 0.2 | 9.1 | 93.5 | 97.6 | 89.1 |
| 870 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5e | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 1.2 | 1.5 | 9.1 | 158 | 151 | NR |
| 871 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5e | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 1.1 | 1.5 | 9.1 | 138 | 136 | NR |
| 872 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5e | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 1.5 | 9.1 | 127 | 123 | NR |
| 873 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5e | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 0.8 | 1.5 | 9.1 | 117 | 112 | NR |
| 874 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5b | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 1.2 | 3.0 | 9.1 | 114 | 111 | 28.0 |
| 875 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5b | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 0.9 | 3.0 | 9.1 | 91.7 | 88.5 | 27.4 |
| 876 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.30 | 25 | 18 | 5b | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 0.8 | 3.0 | 9.1 | 80.6 | 80.0 | NR |
| 877 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5c | 150 | 7.59 | 0.44 | 2.63 | 2.3 | 12.0 | 0 | 0.0 | 1.1 | 5.0 | 9.1 | 74.1 | 73.5 | 27.6 |
| 878 | [12] | AEDC | 1965 | Air | 300 | CON | 2.11 | 0.31 | 25 | 18 | 5c | 150 | 7.59 | 0.44 | 2 | | | | | | | | | | |

Table 5.3 (Continued) - Cold-Flow Cylindrical and Second-Throat Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Diffuser Configuration | | | | | | | | | | Performance | | | | | |
|-----|---------|----------|------|----------------------|----------------|---------------------------|-----------------|---------------------|----------------------------------|------------------------|-------|----------------------------------|-----------------|----------------------------------|----------------------------------|----------------------------------|-----------------|-----------------|------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|--|------|
| | | | | Gas | T ₀ | Type | D _{nr} | Ref. P ₀ | A _{NE} /A _{NT} | θ _{NE} | Name | A _{DI} /A _{NI} | M _{DI} | A _{DT} /A _{DI} | A _{DT} /A _{NE} | A _{DE} /A _{DT} | θ _{DI} | θ _{DT} | θ _{SUB} | L _{DI} /D _{DI} | L _{DT} /D _{DT} | L _D /D _{DT} | P ₀ /P _{BACK} | (P _{CELL} /P ₀) × 10 ⁵ | |
| | | | | [K] | [cm] | [MPa] | [deg] | < [deg] > | | | | | | | | | | Start | Unst. | | | | | | |
| 905 | [58] | ISRO | 1998 | N2 | 300 | CON | 0.91 | 4.50 | 20 | 20.5 | - | 33.0 | 5.35 | 1.00 | 1.65 | - | - | 0 | - | - | 7.1 | 7.1 | 28.5 | 28.5 | 87.7 |
| 906 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.74 | 4.00 | 9.0 | 20.5 | 1 | 11.1 | 4.04 | 1.00 | 1.23 | - | - | 0 | - | - | 8.0 | 8.0 | 9.5 | 9.5 | NR |
| 907 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.20 | 4.00 | 19 | 20.5 | 2 | 31.3 | 5.29 | 1.00 | 1.65 | - | - | 0 | - | - | 8.0 | 8.0 | 26.8 | 26.8 | NR |
| 908 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.14 | 4.00 | 21 | 20.5 | 3 | 54.6 | 5.42 | 1.00 | 1.65 | - | - | 0 | - | - | 8.0 | 8.0 | 29.2 | 29.2 | NR |
| 909 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.17 | 4.00 | 20 | 20.5 | 4 | 79.2 | 6.58 | 1.00 | 3.96 | - | - | 0 | - | - | 9.0 | 9.0 | 65.0 | 65.0 | NR |
| 910 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.14 | 4.00 | 20.8 | 20.5 | 5 | 82.8 | 6.65 | 1.00 | 3.98 | - | - | 0 | - | - | 9.0 | 9.0 | 68.5 | 68.5 | NR |
| 911 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.20 | 4.00 | 18.9 | 20.5 | 6 | 124 | 7.28 | 1.00 | 6.56 | - | - | 0 | - | - | 8.7 | 8.7 | 102 | 102 | NR |
| 912 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.17 | 4.00 | 20 | 20.5 | 7 | 131 | 7.37 | 1.00 | 6.53 | - | - | 0 | - | - | 8.7 | 8.7 | 108.5 | 108.5 | NR |
| 913 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.14 | 4.00 | 20.8 | 20.5 | 8 | 137 | 7.44 | 1.00 | 6.56 | - | - | 0 | - | - | 8.7 | 8.7 | 109.5 | 109.5 | NR |
| 914 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.20 | 4.00 | 18.9 | 20.5 | 9 | 214 | 8.21 | 1.00 | 11.3 | - | - | 0 | - | - | 8.9 | 8.9 | 185.0 | 185.0 | NR |
| 915 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.17 | 4.00 | 19.9 | 20.5 | 10 | 225 | 8.30 | 1.00 | 11.3 | - | - | 0 | - | - | 8.9 | 8.9 | 202.5 | 202.5 | NR |
| 916 | [37] | ISRO | 1998 | N2 | 300 | CON | 1.14 | 4.00 | 20.8 | 20.5 | 11 | 235 | 8.38 | 1.00 | 11.3 | - | - | 0 | - | - | 8.9 | 8.9 | 215.0 | 215.0 | NR |
| 917 | [59] | KAU | 2007 | N2 | 288 | NR | NR | 5.07 | 5.7 | NR | - | 28.4 | 5.16 | 1.00 | 5.00 | NR | - | 0 | NR | - | 5.0 | 6.6 | 22.5 | 22.5 | 289 |
| 918 | [60] | KAU | 2008 | N2 | AMB | CON | 0.28 | NR | 35.0 | 15 | - | 56.3 | 6.08 | 1.00 | 1.61 | - | - | 0 | NR | - | NR | 12.4 | 39.9 | NR | |
| 919 | [60] | KAU | 2008 | N2 | AMB | CON | 0.32 | NR | 26.8 | 15 | - | 43.1 | 5.71 | 1.00 | 1.61 | - | - | 0 | NR | - | NR | 12.4 | 31.7 | NR | |
| 920 | [60] | KAU | 2008 | N2 | AMB | CON | 0.43 | NR | 14.6 | 15 | - | 23.4 | 4.92 | 1.00 | 1.61 | - | - | 0 | NR | - | NR | 12.4 | 19.0 | NR | |
| 921 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | A-1 | 30.0 | 5.23 | 0.63 | 1.20 | NR | 6.0 | 0 | - | 1.0 | 8.0 | NR | 18.1 | NR | NR |
| 922 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | A-2 | 30.0 | 5.23 | 0.63 | 1.20 | NR | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 15.1 | NR | NR |
| 923 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | B-1 | 40.0 | 5.61 | 0.63 | 1.60 | NR | 6.0 | 0 | - | 1.0 | 8.0 | NR | 22.2 | NR | NR |
| 924 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | B-2 | 40.0 | 5.61 | 0.63 | 1.60 | NR | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 20.2 | NR | NR |
| 925 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | C-1 | 50.0 | 5.91 | 0.63 | 2.00 | NR | 6.0 | 0 | - | 1.0 | 8.0 | NR | 27.6 | NR | NR |
| 926 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | C-2 | 50.0 | 5.91 | 0.63 | 2.00 | NR | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 21.8 | NR | NR |
| 927 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | D-1 | 60.0 | 6.17 | 0.63 | 2.40 | NR | 6.0 | 0 | - | 1.0 | 8.0 | NR | 33.5 | NR | NR |
| 928 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 25 | 15 | D-2 | 60.0 | 6.17 | 0.63 | 2.40 | NR | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 30.3 | NR | NR |
| 929 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 3.55 | 4.9 | 15 | E | 60.0 | 6.17 | 0.63 | 2.40 | NR | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 30.3 | NR | NR |
| 930 | [61] | YSU | 2008 | N2 | AMB | TOP | NR | 1.90 | 18.2 | NR | G-1 | 24.7 | 4.98 | 0.61 | 0.82 | NR | 6.0 | 0 | 6.0 | 1+ | 8+ | NR | 18.7 | NR | NR |
| 931 | [61] | YSU | 2008 | N2 | AMB | CON | NR | 1.90 | 18.2 | 18 | G-2 | 24.7 | 4.98 | 0.61 | 0.82 | NR | 6.0 | 0 | 6.0 | 1+ | 8+ | NR | 18.7 | NR | NR |
| 932 | [61] | YSU | 2008 | N2 | AMB | TIC | NR | 4.83 | 69.5 | NR | I-1 | 130 | 7.36 | 0.77 | 1.44 | 3.0 | 6.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 4.76 | NR | NR |
| 933 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 1 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 8.0 | 15.7 | 43.6 | NR | NR |
| 934 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 1 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 0.0 | 8.0 | 10.7 | 42.0 | NR | NR |
| 935 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 2 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 0.5 | 8.0 | 15.7 | 41.8 | NR | NR |
| 936 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 3 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 0.0 | 8.0 | 15.7 | 41.5 | NR | NR |
| 937 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 4 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 3.0 | 15.7 | 50.0 | NR | NR |
| 938 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 5 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 4.0 | 15.7 | 48.5 | NR | NR |
| 939 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 6 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 5.0 | 15.7 | 45.5 | NR | NR |
| 940 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 7 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 7.0 | 15.7 | 45.1 | NR | NR |
| 941 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 8 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 9.0 | 15.7 | 42.0 | NR | NR |
| 942 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 9 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 12.0 | 15.7 | 41.8 | NR | NR |
| 943 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 10 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 8.0 | 10.7 | 46.6 | NR | NR |
| 944 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | 11 | 84.2 | 6.67 | 0.67 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 8.0 | 20.8 | 41.5 | NR | NR |
| 945 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | A | 70.7 | 6.41 | 0.76 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.1 | 8.0 | NR | 46.5 | NR | NR |
| 946 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | B | 104 | 7.00 | 0.52 | NR | 9.7 | 5.0 | 0 | 6.0 | 0.9 | 8.0 | NR | 51.4 | NR | NR |
| 947 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | C | 125 | 7.29 | 0.43 | NR | 9.7 | 5.0 | 0 | 6.0 | 0.8 | 8.0 | NR | 58.8 | NR | NR |
| 948 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | D | 84.2 | 6.67 | 0.64 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 8.0 | NR | 46.6 | NR | NR |
| 949 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | E | 84.2 | 6.67 | 1.00 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 6.4 | NR | 65.5 | NR | NR |
| 950 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | F | 84.2 | 6.67 | 0.80 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 7.1 | NR | 56.8 | NR | NR |
| 951 | [62-63] | CNU | 2013 | N2 | AMB | CON | 0.20 | 4.30 | NR | NR | G | 84.2 | 6.67 | 0.57 | NR | 9.7 | 5.0 | 0 | 6.0 | 1.0 | 13.5 | NR | 48.9 | NR | NR |
| 952 | [40] | ISRO | 2015 | N2 | NR | NR | NR | 4.00 | 70 | NR | SVC | 89.0 | 6.76 | 0.50 | 0.64 | 4.0 | 6.0 | 0 | 5.0 | 1.0 | 8.0 | 17.1 | 34.5 | 31.6 | 17.1 |
| 953 | [64] | STRI | 2019 | Air | 300 | NR | 0.72 | NR | 53 | NR | - | 70.0 | 6.40 | 0.54 | 1.32 | 4.0 | 6.0 | 0 | 6.0 | 0.8 | 8.0 | NR | 30.3 | 28.0 | NR |
| 954 | [64] | STRI | 2019 | Air | 300 | NR | 0.86 | NR | 37 | NR | - | 45.6 | 5.79 | 0.59 | 1.23 | 4.0 | 6.0 | 0 | 6.0 | 0.8 | 8.0 | NR | 27.0 | 19.2 | NR |
| 955 | [64] | STRI | 2019 | Air | 300 | NR | 0.86 | NR | 37 | NR | - | 45.6 | 5.79 | 0.56 | 1.23 | 4.0 | 6.0 | 0 | 6.0 | 0.8 | 8.0 | NR | 27.3 | 19.0 | NR |
| 956 | [64] | STRI | 2019 | Air | 300 | NR | 0.78 | NR | 45 | NR | - | 57.9 | 6.12 | 0.55 | 1.29 | 4.0 | 6.0 | 0 | 6.0 | 0.8 | 8.0 | NR | 33.5 | 23.7 | NR |
| 957 | [42] | NASA SSC | 2020 | N2 | 301 | TOP | 0.343 | 18.94 | 69.4 | 5.4 | ND4-E | 90.4 | 5.84 | 0.57 | 0.74 | - | 6.0 | 0 | - | 0.44 | 2.75 | 4.87 | 64.7 | 57.4 | 73.0 |
| 958 | [42] | NASA SSC | 2020 | N2 | 301 | TOP | 0.475 | 9.89 | 36.5 | 6.0 | ND4-E | 47.5 | 5.84 | 0.57 | 0.74 | - | 6.0 | 0 | - | 0.44 | 2.75 | 4.87 | 35.4 | 27.0 | 129 |
| 959 | [42] | NASA SSC | 2021 | N2 | 299 | FAIR | 0.318 | 4.39 | 15 | 0.0 | CYL-E | 36.2 | 5.48 | 1.00 | 2.41 | - | - | 0 | - | - | 11.6 | 11.6 | 31.0 | 31.0 | 171 |
| 960 | [65] | PU | 2021 | N2 | AMB | TOP | 0.305 | 2.76 | 25 | 15.0 | #1 | 4.78 | 5.85 | 0.57 | 1.09 | NR | 6.0 | 0 | 7.0 | 1.0 | 8.0 | NR | 21.5 | 20.0 | NR |
| 961 | [65] | PU | 2021 | N2 | AMB | TOP, θ _n = 29° | 0.305 | 2.76 | 25 | 7.0 | #1 | 4.78 | 5.85 | 0.57 | 1.09 | NR | 6.0 | 0 | 7.0 | 1.0 | 8.0 | NR | 22.3 | 20.6 | NR |
| 962 | [65] | PU | 2021 | N2 | AMB | TOP, θ _n = 38° | 0.305 | 2.76 | 25 | 7.0 | #1 | 4.78 | 5.85 | 0.57 | 1.09 | NR | 6.0 | 0 | 7.0 | 1.0 | 8.0 | NR | 26.2 | 20.8 | NR |
| 963 | [65] | PU | 2021 | CO2 | AMB | TOP, θ _n = 29° | 0.305 | 2.76 | 25 | 7.0 | #2 | 4.78 | 6.03 | 0.63 | 1.20 | NR | 6.0 | 0 | 7.0 | 1.0 | 8.0 | NR | 19.7 | 19.4 | 150 |
| 964 | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 7 - Spike Diffuser Data

| No. | Ref. | Entity | Year | Nozzle Configuration | | | | | | Shell Configuration | | | | | | Spike Configuration | | | | | | Performance | | | | | |
|------|------|-----------|------|----------------------|------|-----------------|---------------------|------------------------------------|-----------------|---------------------|------------------------------------|-----------------|------------------------------------|-----------------|------------------|---------------------|-------------------------------------|------------------------------------|------|------|------------------|-------------|----|-------------------------------------|---|-------|------|
| | | | | Prop. | Type | D _{NT} | Ref. P ₀ | A _{NE} A _{NT} | θ _{NE} | Name | A _{DI} A _{NT} | M _{DI} | L _{DI} D _{DI} | θ _{DI} | θ _{SHL} | Δ | D _{TIP} D _{DI} | I _{SPK} / D _{DI} | | | θ _{SPK} | | | P ₀ P _{BACK} | (P _{CELL} P ₀) x10 ⁵ | | |
| | | | | | | | | | | | | | | | | | | 1 | 2 | 3 | 1 | 2 | 3 | | Start | Unst. | |
| | | | | O:F | | | | | | Hot-Fire Data | | | | | | | | | | | | | | | | | |
| 1015 | [42] | NASA SSC | 2020 | GOX/GH2 | 6.1 | TOP | 0.318 | 4.14 | 76.9 | 19 | SPK-3X-E | 107.6 | 4.74 | 0.38 | -5.7 | 21.1 | 0.37 | 0.13 | 1.73 | - | - | 24 | - | - | 41.0 | 39.5 | 254 |
| 1016 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.1 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-1X | 106.9 | 4.76 | 0.38 | -5.7 | 21.1 | 0.47 | 0.00 | 1.82 | - | - | 24 | - | - | 34.6 | 32.3 | 104 |
| 1017 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.1 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-2X | 106.9 | 4.76 | 0.38 | -5.7 | 21.1 | 0.42 | 0.09 | 1.77 | - | - | 24 | - | - | 34.9 | 32.7 | 101 |
| 1018 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.1 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-3X | 106.9 | 4.76 | 0.38 | -5.7 | 21.1 | 0.38 | 0.18 | 1.75 | - | - | 24 | - | - | 35.2 | 33.1 | 102 |
| 1019 | [TR] | NASA SSC | 2021 | LOX/GH2 | 5.8 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-3X | 106.9 | 4.85 | 0.38 | -5.7 | 21.1 | 0.37 | 0.18 | 1.75 | - | - | 24 | - | - | 35.7 | 33.7 | 110 |
| 1020 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.0 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-4X | 106.9 | 4.79 | 0.38 | -5.7 | 21.1 | 0.36 | 0.22 | 1.73 | - | - | 24 | - | - | 35.3 | 34.0 | 113 |
| 1021 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.1 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-4X | 106.9 | 4.76 | 0.38 | -5.7 | 21.1 | 0.35 | 0.22 | 1.73 | - | - | 24 | - | - | 36.3 | 34.7 | 107 |
| 1022 | [TR] | NASA SSC | 2021 | LOX/GH2 | 5.6 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-4X | 106.9 | 4.91 | 0.38 | -5.7 | 21.1 | 0.35 | 0.22 | 1.73 | - | - | 24 | - | - | 37.8 | 35.9 | 116 |
| 1023 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.0 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-3Y | 106.9 | 4.79 | 0.38 | -5.7 | 21.1 | 0.38 | 0.18 | 1.73 | - | - | 24 | - | - | 36.2 | 34.7 | 98.2 |
| 1024 | [TR] | NASA SSC | 2021 | LOX/GH2 | 6.1 | TOP | 2.312 | 3.55 | 76.7 | 19 | SPK-4Y | 106.9 | 4.76 | 0.38 | -5.7 | 21.1 | 0.36 | 0.22 | 1.71 | - | - | 24 | - | - | 35.0 | 34.9 | 89.9 |
| | | | | TO [K] | | | | | | Intermediate Data | | | | | | | | | | | | | | | | | |
| 1025 | [42] | NASA SSC | 2020 | C2H6 | 535 | TOP | 0.318 | 3.55 | 76.9 | 19 | SPK-3X-E | 107.6 | 4.7 | 0.38 | -5.7 | 21.1 | 0.37 | 0.13 | 1.72 | - | - | 24 | - | - | 35.2 | 32.7 | 123 |
| 1026 | [42] | NASA SSC | 2020 | C2H6 | 635 | TOP | 0.376 | 10.34 | 100 | 14.8 | SPK-SRP-E | 111.5 | 4.49 | 0.27 | -5.7 | 21.1 | 0.54 | 0.13 | 1.93 | - | - | 24 | - | - | 29.1 | 27.2 | 220 |
| 1027 | [42] | NASA SSC | 2020 | C2H6 | 635 | TOP | 0.318 | 10.34 | 14.0 | 11.2 | SPK-SRP-E | 156.3 | 4.72 | 0.27 | -5.7 | 21.1 | 0.54 | 0.13 | 1.93 | - | - | 24 | - | - | 40.1 | 40.1 | 170 |
| 1028 | [42] | NASA SSC | 2020 | C2H6 | 635 | TOP | 0.282 | 10.34 | 177 | 7.5 | SPK-SRP-E | 198.2 | 4.89 | 0.27 | -5.7 | 21.1 | 0.54 | 0.13 | 1.93 | - | - | 24 | - | - | 56.5 | 47.4 | 75.2 |
| | | | | | | | | | | Cold-Flow Data | | | | | | | | | | | | | | | | | |
| 1029 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.40 | 0.0 | 10.8 | NR | 0.0 | - | - | - | 12 | - | - | 15.8 | 10.2 | NR |
| 1030 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.97 | 0.0 | 12.0 | NR | 0.0 | - | - | - | 12 | - | - | 18.8 | 9.9 | NR |
| 1031 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.74 | 0.0 | 10.8 | NR | 0.0 | - | - | - | 15 | - | - | 14.6 | 9.4 | NR |
| 1032 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.00 | 0.0 | 12.0 | NR | 0.0 | - | - | - | 15 | - | - | 17.0 | 10.2 | NR |
| 1033 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 13.3 | NR | 0.0 | - | - | - | 15 | - | - | 15.2 | 9.2 | NR |
| 1034 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 15.0 | NR | 0.0 | - | - | - | 15 | - | - | 18.0 | 10.2 | NR |
| 1035 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 21.5 | NR | 0.0 | - | - | - | 15 | - | - | 25.1 | 17.0 | NR |
| 1036 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.28 | 0.0 | 21.5 | NR | 0.0 | - | - | - | 24 | - | - | 11.4 | 9.7 | NR |
| 1037 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.74 | 0.0 | 24.0 | NR | 0.0 | - | - | - | 24 | - | - | 18.4 | 15.2 | NR |
| 1038 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.74 | 0.0 | 27.4 | NR | 0.0 | - | - | - | 30 | - | - | 17.2 | 11.4 | NR |
| 1039 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.74 | 0.0 | 30.0 | NR | 0.0 | - | - | - | 30 | - | - | 19.4 | 14.2 | NR |
| 1040 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.17 | 0.0 | 13.3 | NR | 0.16 | - | - | - | 15 | - | - | 18.7 | 10.9 | NR |
| 1041 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.71 | 0.0 | 13.3 | NR | 0.32 | - | - | - | 15 | - | - | 23.5 | 12.4 | NR |
| 1042 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.66 | 0.0 | 13.3 | NR | 0.48 | - | - | - | 15 | - | - | 28.4 | 16.1 | NR |
| 1043 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 27.4 | NR | 0.0 | 1.55 | - | - | 15 | 30 | - | 17.6 | 12.4 | NR |
| 1044 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 0.94 | 0.0 | 30.0 | NR | 0.0 | 1.17 | - | - | 15 | 30 | - | 22.1 | 19.2 | NR |
| 1045 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 30.0 | NR | 0.0 | 1.36 | - | - | 15 | 30 | - | 21.2 | 16.8 | NR |
| 1046 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.17 | 0.0 | 30.0 | NR | 0.0 | 1.55 | - | - | 15 | 30 | - | 23.2 | 11.6 | NR |
| 1047 | [21] | NASA LeRC | 1962 | N2 | NR | CON | 0.66 | 3.04 | 25.0 | 15.0 | - | 35.4 | 5.45 | 1.20 | 0.0 | 30.0 | NR | 0.0 | 1.75 | - | - | 15 | 30 | - | 28.4 | 10.4 | NR |
| 1048 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.65 | 0.0 | 8.0 | 0.65 | 0.16 | 1.96 | - | - | 12 | - | - | 3.7 | NR | 3460 |
| 1049 | [22] | AEDC | 1973 | Air | NR | CON | 6.43 | NR | 1.7 | 18.0 | - | 5.8 | 3.33 | 1.65 | 0.0 | 8.0 | 0.52 | 0.16 | 1.96 | - | - | 12 | - | - | 5.4 | NR | 1672 |
| 1050 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.59 | 0.0 | 12.5 | 0.46 | 0.0 | 1.44 | 0.66 | - | 18 | 15 | - | 3.5 | NR | 7520 |
| 1051 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.59 | 0.0 | 12.5 | 0.54 | 0.0 | 1.44 | 0.66 | - | 18 | 15 | - | 4.0 | NR | 6050 |
| 1052 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.59 | 0.0 | 12.5 | 0.63 | 0.0 | 1.44 | 0.66 | - | 18 | 15 | - | 4.3 | NR | 3530 |
| 1053 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.59 | 0.0 | 12.5 | 0.71 | 0.0 | 1.44 | 0.66 | - | 18 | 15 | - | 4.1 | NR | 3410 |
| 1054 | [22] | AEDC | 1973 | Air | NR | CON | 7.72 | NR | 1.6 | 18.0 | - | 4.0 | 2.94 | 1.59 | 0.0 | 12.5 | 0.60 | 0.0 | 0.67 | 0.70 | 0.66 | 12 | 25 | 14.1 | 4.8 | NR | 3460 |
| 1055 | [22] | AEDC | 1973 | Air | NR | CON | 6.43 | NR | 1.7 | 18.0 | - | 5.8 | 3.33 | 1.59 | 0.0 | 12.5 | 0.48 | 0.0 | 0.67 | 0.70 | 0.66 | 12 | 25 | 14.1 | 3.2 | NR | 5460 |
| 1056 | [23] | AEDC | 1974 | Air | NR | CON | 5.21 | NR | 3.0 | 13.3 | - | 8.8 | 3.78 | 1.31 | 0.0 | 8.0 | 0.41 | 0.16 | 1.96 | - | - | 12 | - | - | 7.5 | NR | 860 |
| 1057 | [23] | AEDC | 1974 | Air | NR | CON | 3.71 | NR | 2.9 | 12.0 | - | 17.3 | 4.55 | 1.31 | 0.0 | 8.0 | 0.33 | 0.16 | 1.96 | - | - | 12 | - | - | 18.1 | NR | 410 |
| 1058 | [23] | AEDC | 1974 | Air | NR | CON | 2.90 | NR | 3.0 | 12.0 | - | 28.4 | 5.16 | 1.31 | 0.0 | 8.0 | 0.33 | 0.16 | 1.96 | - | - | 12 | - | - | 28.0 | NR | 342 |