NMC
Committed to Nuclear Excellence

Point Beach Nuclear Plant
Operated by Nuclear Management Company, LLC

November 24, 2003

NRC 2003-0112
10 CFR 50.54(f)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266 and 50-301
License Nos. DPR-24 and DPR 27
Supplemental Response To NRC Bulletins 2001-01, 2002-01, And 2002-02 For
Reactor Vessel Head And Vessel Head Penetration Nozzle Inspection Findings

Reference: 1) Letter from Nuclear Management Company, LLC to Document Control Desk, "Thirty-day response to NRC Bulletins 2001-01, 2002-01 and for 2002-02 for Reactor Vessel Head and Vessel Head Penetration Nozzle Inspection Findings", dated November 15, 2002.

In the referenced letter, Nuclear Management Company, LLC (NMC), provided its response to Bulletins 2001-01, 2002-01, and 2002-02 regarding reactor vessel head and vessel head penetration nozzle inspection findings obtained during the refueling outage of Point Beach Nuclear Plant (PBNP) Unit 1 that was completed on October 16, 2002 (U1R27). This response included a discussion of the inspection scope and results, details of the non-destructive examination used, and the acceptability of the limited ultrasonic testing (UT) examinations performed on four of the forty-nine penetrations.

During an additional review of U1R27 control rod drive mechanism (CRDM) ultrasonic data by Framatome ANP in August 2003, it was discovered that in eleven (11) of the twenty (20) CRDM nozzles inspected with the rotating probe head, probe rotational stalling occurred that was not identified during the initial data analysis. The effect of the probe stalling resulted in areas that were not covered by all six inspection angles contained in the rotating head. Scans using the UT blade probes were unaffected by this situation.

A088
A095
A096

6590 Nuclear Road • Two Rivers, Wisconsin 54241
Telephone: 920.755.2321

Although undetected tool slippage occurred on a small percentage of the nozzles, the inspections performed support the conservative engineering evaluations previously performed and continue to provide assurance of the structural integrity of all PBNP Unit 1 vessel head penetrations. The analysis in the referenced letter continues to bound this condition.

Since this condition impacted the information that was provided in the referenced letter, a supplemental response is proved in the enclosure to this letter.

Framatome ANP notified NMC of this condition in September 2003 and issued a Framatome Nonconformance Report (NCR) 602883. A copy of NCR 602883 is included with the enclosure to this letter. NMC subsequently informed the Point Beach resident NRC inspector and NRC Region III staff of this condition. Framatome ANP has modified the subject tooling to prevent recurrence of this condition in future outages. This modified tooling was deployed at PBNP during U2R26 (October 2003) and operated appropriately.

This letter contains no new commitments and no revisions to existing commitments.

I declare under penalty of perjury that the foregoing is true and accurate. Executed on November 25, 2003.

A. J. Cayia
Site Vice-President, Point Beach Nuclear Plant
Nuclear Management Company, LLC

Enclosures

cc: Administrator, Region III, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
Resident Inspector, Point Beach Nuclear Plant, USNRC

ENCLOSURE 1
PBNP Unit 1 Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Discussion

Introduction

In the referenced letter, Nuclear Management Company, LLC (NMC) submitted its results of inspections performed on the reactor vessel head and vessel head penetration nozzle inspection findings during the refueling outage of Point Beach Nuclear Plant (PBNP) Unit 1 that was completed on October 16, 2002. During an additional review of U1R27 control rod drive mechanism (CRDM) ultrasonic data by Framatome ANP in August 2003, it was discovered that in eleven (11) of the twenty (20) CRDM nozzles inspected with the rotating probe head, probe rotational stalling occurred that was not identified during the initial data analysis. The effect of the probe stalling resulted in areas that were not covered by all six inspection angles contained in the rotating head. Scans using the ultrasonic testing (UT) blade probes were unaffected by this situation.

This supplemental response provides our revised evaluation of the inspection results. Only changes to the previously reported inspection results are included in this correspondence.

PBNP Unit 1 Inspection Scope and Results

Visual Examinations

The slipping of the Framatome ANP UT inspection tooling had no effect on visual exams performed.

Ultrasonic Examinations

NMC to NRC letter dated November 15, 2002 discussed limitations in scanning of four (4) of the thirty-three (33) nozzles with thermal sleeves using the UT blade probe. These limited scans were justified to be acceptable through engineering analysis. The slippage to the rotating tool head did not affected these scans and therefore, this information will not be presented again.

All nozzles without thermal sleeves (16) were examined using a rotating probe UT technique. Four (4) other penetrations were also scanned with the rotating probe following removal of their thermal sleeves. A total of twenty (20) nozzles were examined with the rotating probe. It is in the population of twenty (20) nozzles that the new lack of coverage was discovered. Details on the equipment malfunction that caused this lack of coverage are included in nonconformance report (NCR) 602883, which is enclosed to this letter.

During the additional review of the U1R27 CRDM examination data it was observed that the weld profiles shown in the C-scan images were not symmetric on 11 of 20 nozzles examined with the rotating probe. Further investigation of the images suggests that the probe stalled during a portion of the rotation. This caused limited coverage of the affected nozzles. Although the entire circumference was examined with at least one transducer, not all of the six transducers in the inspection head covered the entire circumference.

Rotating UT was performed on nozzle numbers 1, 6-9, 31-37, & 42-49. The nozzles affected by probe stalling are 8, 31-33, 36, 37, 42, & 44-47. The unaffected nozzles were determined not to have stalled by verifying the symmetry of the weld profile and matching the elevations of the upper and lower edges of the J-groove weld at the beginning and end of the scan rotation.

Nozzle 1 is in the center of the head and so there is no detectable change in the weld symmetry because the geometry is constant around the circumference. This nozzle was verified to have complete coverage by doing a detailed comparison of landmarks detected at the weld fusion interface with the blade UT examination that was also performed on this nozzle.

UT examinations and "UT leak path" were also affected in the eleven (11) nozzles. The stall conditions resulted in some portion of the circumference where the transducers used to make the leak path assessment were not scanned. Table 1 summarizes all limitation in UT scans performed during U1R27. For the eleven (11) nozzles that had slippage of the rotating tool, no coverage percentage is listed in the table. This information is discussed in NCR 602883 (enclosed) due to the varying coverage percentage by transducer.

Table 1
Revised Inspection Summary

Penetration(s)	Coverage	Description
1	100%	Indications of possible fabrication-related flaw indications found through blade probe UT examination. Thermal sleeve removed to initiate repairs. 100% rotating UT performed with sleeve removed. Indications determined to be weld fabrication-related with the more accurate rotating probe UT. No indications found with confirmatory PT examination. No repairs required. Thermal sleeve reinstalled.
2 – 7	100%	No indications. No restrictions or limitations.
8	*Tool* Slippage	*Rotating probe tool slippage occurred. Coverage limitation* detailed on pages 4-5 of the enclosed NCR 602883 discussion.
9 - 25	100%	No indications. No restrictions or limitations
26	78%	No indications. Limited blade probe coverage justified through engineering analysis.
27	66%	No indications. Limited blade probe coverage justified through engineering analysis.
28	52%	No indications. Limited blade probe coverage justified through engineering analysis.
29	100%	No indications. No restrictions or limitations.
30	50%	No indications. Limited blade probe coverage justified through engineering analysis.
31-33	Tool Slippage	Very limited initial coverage using blade probe due to physical restrictions. Thermal sleeve removed. Rotating probe tool slippage occurred. Coverage limitation detailed on pages 6 –11 of the enclosed NCR 602883 discussion. Nozzle 32 had weld fabrication-related indications only. No flaw indications. Thermal sleeve installed.
34 – 35	100%	No indications. No restrictions or limitations.
36 - 37	Tool Slippage	Rotating probe tool slippage occurred. Coverage limitation detailed on pages 12 - 15 of NCR 602883 discussion.
38 - 41	100%	No indications. No restrictions or limitations.
42	Tool Slippage	Rotating probe tool slippage occurred. Coverage limitation detailed on pages 16 - 17 of NCR 602883 discussion.
43	100%	No indications. No restrictions or limitations.
44 - 47	Tool Slippage	Rotating probe tool slippage occurred. Coverage limitation detailed on pages 18 - 25 of NCR 602883 discussion.
48 - 49	100%	No indications. No restrictions or limitations.

Flaw Tolerance Evaluation

Circumferential cracks located in the nozzle material are the area of prime interest due to the safety concern arising from nozzle ejection and loss of coolant accident (LOCA). Therefore, a flaw tolerance evaluation, postulating a circumferential flaw in the region that was not interrogated by the UT examination was performed by Westinghouse Electric Company.

In the Letter from NMC to NRC dated November 15, 2002, a discussion of the acceptability of an assumed 180° flaw was presented. This evaluation concluded that the time required for a postulated 180° circumferentially oriented flaw to grow to a point of structural instability (330°) to be approximately 25 years of operation. The evaluation used plant specific stresses and operating temperature and the MRP-55 crack growth rate predictions. The UT results and the cited evaluation established that there were no concerns with the structural integrity of the vessel head penetrations (VHPs) associated with the possibility of undetected circumferential cracking in the non-inspected areas over at least the next operating cycle.

This evaluation bounds the lack of coverage documented in Framatome (NCR) 602883 as all nozzles with rotating tool slippage had coverage that exceeded 180° circumferentially.

Probabilistic Evaluation

As described in the Letter from NMC to NRC dated November 15, 2002, Westinghouse Electric Company performed a probabilistic analysis on the subject of lack of coverage. This work determined, with at least 95% confidence, that the seven penetrations with initial limitations in examination coverage would not produce an axial or circumferential flaw that would exceed the assumed critical sizes over a time interval of up to 14.5 additional effective full power years (EFPYs). This conclusion was based on conservative assumptions in average crack size, stresses influencing crack growth, and inspections performed to date.

The results of the probabilistic analysis were then evaluated using the plant specific probabilistic risk assessment (PRA) to determine the potential risk significance of this activity. NMC conservatively postulated that a critical failure would lead to a medium LOCA with an equivalent diameter of more than 2 inches. The corresponding change in core damage frequency for this scenario was calculated to be less than 1E-6/year. These results demonstrate a very small change in plant risk and are consistent with the guidance contained within Regulatory Guide 1.174.

This probabilistic evaluation is still considered applicable as each of the eleven (11) nozzles that had rotating tool slippage had coverage with at least one transducer for 100% of the nozzle circumference.

100% Visual and Other UT Examinations

The detailed 100% UT examinations of a large majority of the CRDM nozzle and of the reactor pressure vessel (RPV) head vent line surface areas, with no evidence of cracking or leakage, give assurance that primary water stress cracking corrosion (PWSCC) of the PBNP Unit 1 VHPs is not occurring. This is also evident in the results of the 100% visual examination performed on the RPV head exterior surface.

PBNP Unit 1 Inspection Summary

In the referenced letter, NMC provided its response to Bulletins 2001-01, 2002-01, and 2002-02 regarding reactor vessel head and vessel head penetration nozzle inspection findings obtained during the refueling outage of PBNP Unit 1, that was completed on October 16, 2002 (U1R27).

As discussed in the previous sections, it was discovered that in eleven (11) of the twenty (20) CRDM nozzles inspected with the rotating probe head, probe rotational stalling occurred that was not identified during the initial data analysis. Framatome ANP notified NMC of this condition in September 2003 and issued a Framatome NCR 602883.

Although undetected tool slippage did occur on a small percentage of the nozzles, the inspections performed support the conservative engineering evaluations previously performed and continue to provide assurance of the structural integrity of all PBNP Unit 1 VHPs.

By letter dated March 3, 2003, NMC consented to the requirements listed in NRC Order EA-03-09, "Issuance of Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors." During the next refueling outage for PBNP Unit 1 (U1R28 - April 2004), NMC will perform UT, PT, and visual examinations that comply with the requirements of NRC Order EA-03-09.

The PBNP Unit 1 RPV Head is scheduled for replacement during the subsequent refueling outage (U1R29 - Fall 2005).

ENCLOSURE 2

Framatome ANP, NCR 602883, Revision 1 (and associated discussion)

FRAMATOME ANP

NONCONFORMANCE REPORT WORKING INSTRUCTION WI-9

NCR# 6028873 | REV.# 1 | PAGE 1 OF 2

SECTION 1 INITIATION

CONTRACT #: 1221016 CUSTOMER/SITE/UNIT: NMC / Pt. Beach Unit 1

TECHNICAL DOCUMENT#: 54-ISI-100-09 SEQUENCE/STEP #:

DESCRIPTION OF NONCONFORMANCE/CONDITION: ☐ QA INITIATED

During a review of CRDM ultrasonic data performed in preparation for the Unit 2 outage, it was discovered that in eleven (11) of the twenty (20) CRDM nozzles inspected with the rotating probe head, probe rotational stalling occurred that was not identified during the initial data analysis. The effect of the probe stalling resulted in areas that were not covered by all six inspection angles contained in the rotating head.

INITIATOR: M. W. Key (NAME) DATE/TIME: 09/21/2003 12:00 AM TAG PLACED ☐ YES ☒ NO

SENT TO: Bob Cole (NAME) REQUESTED COMPLETION DATE: 9//30/2003

SECTION 2 RESOLUTION AND DISPOSITION

NCR CLASSIFICATION: ☒ SAFETY-RELATED ☐ NON SAFETY-RELATED ☐ ASME CODE

SIGNIFICANCE LEVEL: ☐ I ☐ II ☐ III ☐ NONE

DISPOSITION OF NCR: ☐ REWORK/REINSPECT ☐ REPAIR/RE-INSPECT ☒ USE AS IS ☐ REPLACE ☐ OTHER

DISPOSITION:

The impact of the stalled rotation of the probe has been evaluated and is discussed in detail in the attachment to this NCR. It has been determined that there is no region of the affected nozzles that has not been examined with at least one beam direction. It has been shown through MRP demonstrations and empirical data from cracked nozzles that one beam direction is sufficient to detect cracking. The rotating probe uses multiple transducers looking in both the axial and circumferential beam directions as well as straight beam and has redundancy to allow improved characterization of detected cracks. Rotating UT data acquired during the last MRP demonstration for CRDM UT examination capability was evaluated using only two channels (ch2 and ch3) in order to assess the detection capability in the limited regions where all transducers were not scanned. Each of the affected nozzles has regions where only ch3 was scanned. EPRI evaluation of the demonstration results are attached and will be forwarded to the utility so that the safety significance can be evaluated.

CAUSE: Personnel CAR/RO REQUIRED ☐ YES ☒ NO NUMBER

VENDOR (if applicable)

PREVENTATIVE ACTIONS:

Perform formal training with all RV head inspection crew members on site prior to RV head inspections in the fall of 2003. Document this via a PTR. Evaluate the tool design for any possibility of tool slippage and correct any issues. Complete a SDCN to procedure 54-ISI-100 requiring personnel to perform appropriate checks to ensure no occurrence of slippage. Revise CRDM Data Analysis Course outline to include instruction on verifying 360 degree coverage with all transducers.

APPLICABLE TO OTHER CONTRACTS: ☒ YES ☐ NO

RESOLUTION:

Perform a review of all nozzle examinations performed to date using the bottom-up tool for rotating UT to determine if other examinations are affected. Have a separate analyst perform an independent review of each nozzle to ensure accuracy.

AFFECTED ORGANIZATION: NDE Services SCHEDULED COMPLETION DATE: 9/30/03

RESPONSIBLE INDIVIDUAL/ENGINEER: Craig Ranson (SIGNATURE) CC Ranson (NAME) 10/3/03 (DATE)

APPROVAL REQUIRED: ☐ ANI/ANII ☒ CUSTOMER ☒ QA ☐ AI INSPECTOR

FRAMATOME ANP

NONCONFORMANCE REPORT CONTINUATION WORK INSTRUCTION WI-9

NCR# 602883 | REV.# 1 | PAGE 2 OF 2

SECTION 3 DISPOSITION APPROVAL

	(SIGNATURE)	(NAME)	(DATE)
REVIEWER:	KJ Hacker	KJ Hacker	10/3/03
UNIT MANAGER: (See Note 1 Below)	C Craig Ranson, C C RANSON FOR BOB COLE	RF Cole	10/3/03
CUSTOMER APPROVAL: (If required)	[signature]	BD KEMP	10/11/03
ANI/ANII/AI / Inspector Review (If required)	N/A	N/A	N/A
QA Approval (If required)	NA Simile	NA Simile	10/4/03

Note: 1: For significance Level I and II NCRs, the Unit Manager's signature indicates that the CAR/RO actions have been completed or for a CAR that work may continue.

SECTION 4 DISPOSITION COMPLETION

THE DISPOSITION ACTIONS SPECIFIED IN SECTION 2 HAVE BEEN COMPLETED.

	(SIGNATURE)	(NAME)	(DATE)
VERIFIED BY:	C Craig Ranson	C CRAIG RANSON	10/27/03
QA VERIFICATION: (If required)	NA Simile	NA Simile	10/30/03

SECTION 5 PREVENTATIVE ACTION COMPLETION

THE PREVENTATIVE ACTIONS SPECIFIED IN SECTION 2 HAVE BEEN COMPLETED. THIS NCR IS CLOSED.

	(SIGNATURE)	(NAME)	(DATE)
VERIFIED BY:	C Craig Ranson	C CRAIG RANSON	10/27/03
QA VERIFICATION: (If required)	NA Simile	NA Simile	10/30/03

DISTRIBUTION

Project Engineer — Records Management - - T5.16 — Other — SM Wright

Unit Technical Manager Bob Cole — QA Nick Simile — Specify

Discussion:

During a recent review of the Pt. Beach, Unit 1 – (U1R27), CRDM examination data it was observed that the weld profiles shown in the C-scan images were not symmetric on 11 of 20 nozzles examined with the rotating probe mounted on the bottom-up delivery tool. Further investigation of the images suggests that the probe stalled during a portion of the rotation. This caused limited coverage of the affected nozzles. Although the entire circumference was examined with at least one transducer, not all of the six transducers in the inspection head covered the entire circumference. The scan pattern performed for the examination was a raster with the probe scanning along the nozzle axis to the specified scan limits and then indexing circumferentially to cover a full 360 degrees.

The tooling used to deliver the probe for this examination is referred to as the bottom-up tool. The probe is mounted on a shaft that extends through the center of the rotating mechanism and is secured to the rotating mechanism with a clam-shell type clamp that contains a pin to engage a hole in the probe shaft. It appears that the pin was not engaged with the hole in the shaft during a portion of some scans. For a portion of each affected scan, without pin engagement the clam shell provided coupling of the shaft to the rotating mechanism allowing the shaft to rotate in the intended fashion when coupled. The circumferential encoding is linked to the rotating mechanism, not the probe shaft. Because the circumferential encoding was functioning normally, the scans executed as intended (-5 deg. to 365 deg.) and full coverage was believed to have been achieved. There was no problem with the axial encoding.

Upon discovery of the problem, discussions were held with the lead data analyst assigned to Pt. Beach for the outage, performed in October 2002, to determine if these anomalies were noticed during the on-site data analysis. The analyst stated that the anomalies were observed and discussed with the tooling technicians during the examination because it was suspected that the tool had stalled during rotations. However, when the tooling technicians investigated they responded that the tool was rotating properly. The stalled condition would only be evident if a frictional load was applied to the head as when it was inside a nozzle. The analyst then assumed that the anomalies were due to asymmetric weld conditions and that there was no problem with the data. This was an inaccurate assessment.

Rotating UT was performed on nozzle numbers 1, 6, 7, 8, 9, 31, 32, 33, 34, 35, 36, 37, 42, 43, 44, 45, 46, 47, 48, and 49. The nozzles affected by probe stalling are 8, 31, 32, 33, 36, 37, 42, 44, 45, 46, and 47. Review of the data shows the stall condition occurring near the end of the scan on nozzle 42 at 1310 hrs. The scanning continued that same day with the rotating probe until 2137 hrs. In that time span, nozzles 37, 8, 47, 46, 36, 7, and 45 were examined (in that order) and all had the stall condition evident in the data display. On the next day, nozzles 35, 7, and 43 were scanned (7 was rescanned for some reason) and the stall

condition was not present on any of those nozzles. Ten days later, after the thermal sleeves had been removed to provide access, nozzles 31, 32, and 33 were examined between 1801 hrs and 1901 hrs. These nozzles also had the stall condition evident in the data. This timeline shows that the stall conditions were limited to specific blocks of time bounding the affected nozzles.

The unaffected nozzles were determined not to have stalled conditions by verifying the symmetry of the weld profile and matching the elevations of the upper and lower edges of the J-groove weld at the beginning and end of the scan rotation. Circumferential overlap exists at the beginning and end of the scan to allow this comparison to occur.

Nozzle 1 is in the center of the head and so there is no detectable change in the weld symmetry because the geometry is constant around the circumference. This nozzle was verified to have complete coverage by doing a detailed comparison of landmarks detected at the weld fusion interface with the blade UT examination that was also performed on this nozzle. Based on this correlation, we can conclude that the rotating probe was rotating for the entire circumference of the nozzle. Also, nozzle 1 was not examined in the windows of time where the stalling occurred. The remaining nozzles were examined with a different type of tool using a blade probe due to the presence of thermal sleeves and are not affected.

The rotating probe contained 6 transducers. Five of the six transducers are on one side of the probe and the sixth transducer is approximately 180 degrees out from the five. Therefore, when the stalling occurred, the result was that not all of the transducers covered the entire circumference. The coverage obtained for each transducer on the nozzles with stalled conditions is listed in the following tables. UT images of the affected nozzles are also attached.

Leak path determinations with UT were also impacted on the affected nozzles. The stall conditions resulted in some portion of the circumference where the transducers used to make the leak path assessment were not scanned. Those limits are listed in the tables and are designated as channel 7 for the purposes of generating the graphs that show the coverage for each of the transducers.

The detection capability of the rotating probe was assessed on MRP mockups. The initial demonstration did not define capability on a channel by channel basis but rather as an aggregate performance for all six of the active channels. In order to determine the impact of not scanning the entire circumference with each of the transducers the MRP demonstration data was reanalyzed separately for channel 2 (30 deg TOFD) and channel 3 (60 shear looking down). These two channels were selected because, between these two channels, the entire circumference of each of the affected nozzles was examined. The results of the analysis of the MRP data for these channels were submitted to EPRI for

evaluation. The EPRI report on detection capability using only these two channels is attached.

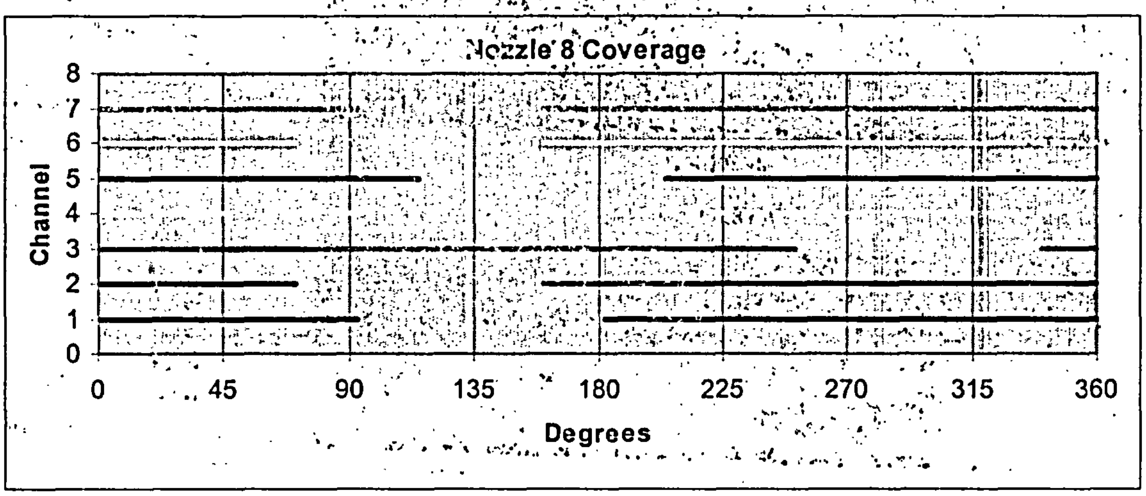
Based on observations from the MRP demonstration program, it was found that axially aimed transducers, optimized for circumferential flaw detection, also detected flaws that were off axis relative to the beam direction. The degree of this off axis orientation was in some cases up to and including 90°. This detection ability to observe off axis flaws was inherent in the circumferentially aimed transducers as well. The attached MRP demonstration results should be consulted to make assessments of the detection capability based on the use of channels 2 and 3 only.

The following tables identify the specific coverage obtained for each of the affected nozzles. The UT image is also attached and annotated to identify the location of the stalled probe condition.

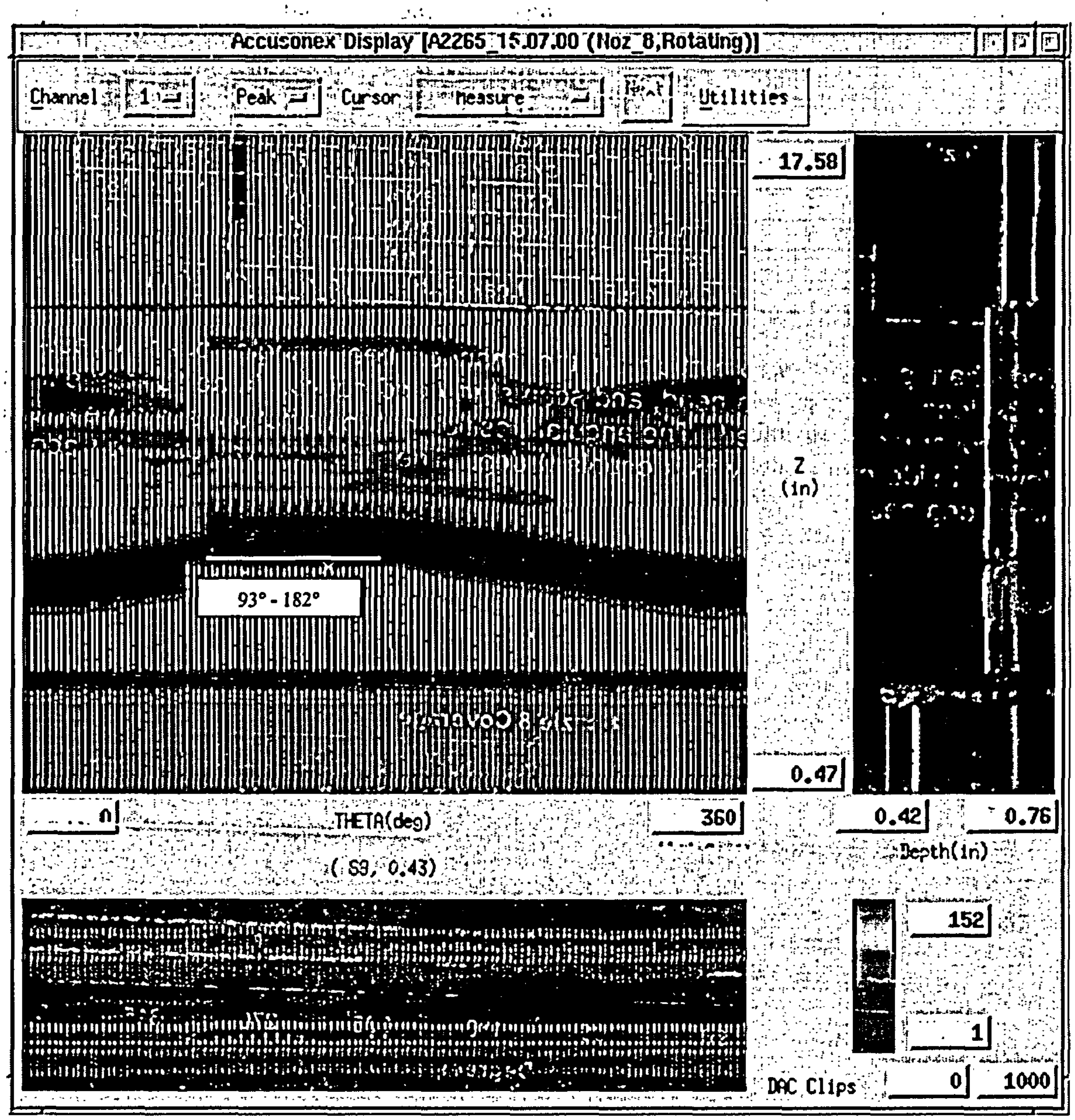
Nozzle 8

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 93	max: 182	Total: 89		
Nozzle 8	1	0	normal	vol	0	93	182
	2	30-L	axial	circ	338	71	160
	3	60-S	axial	circ	158	251	340
	4	45-LE	circ	axial	0	93	182
	5	60-SE	circ	axial	22	115	204
	6	60-SE	circ	axial	338	71	160
	7	0, 30L, 45LE	Leak Path		combined	93	160

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 8

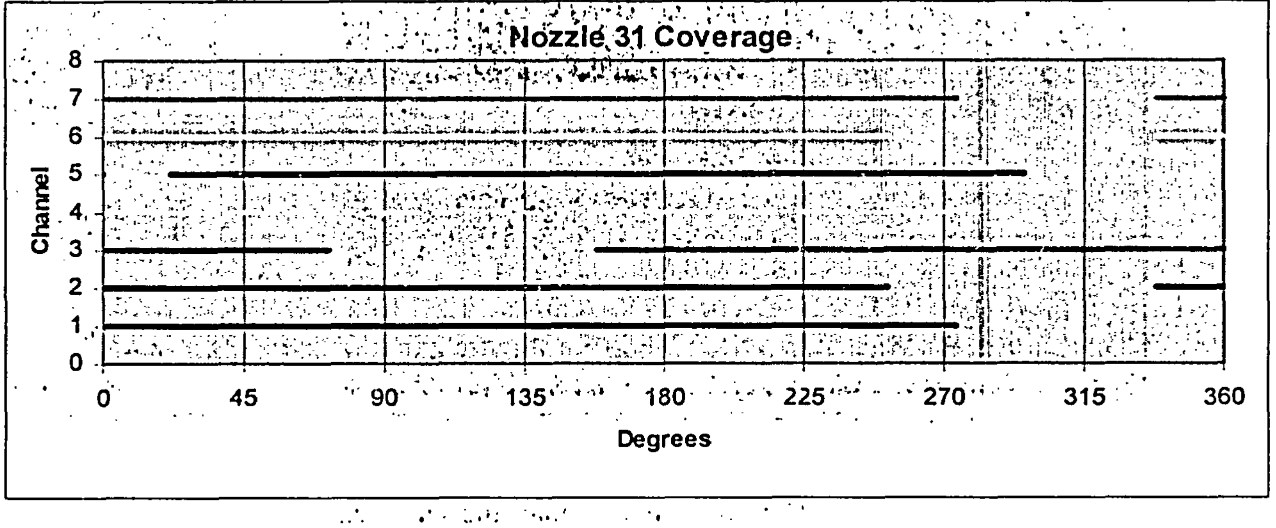


Horizontal line denotes the stall area.

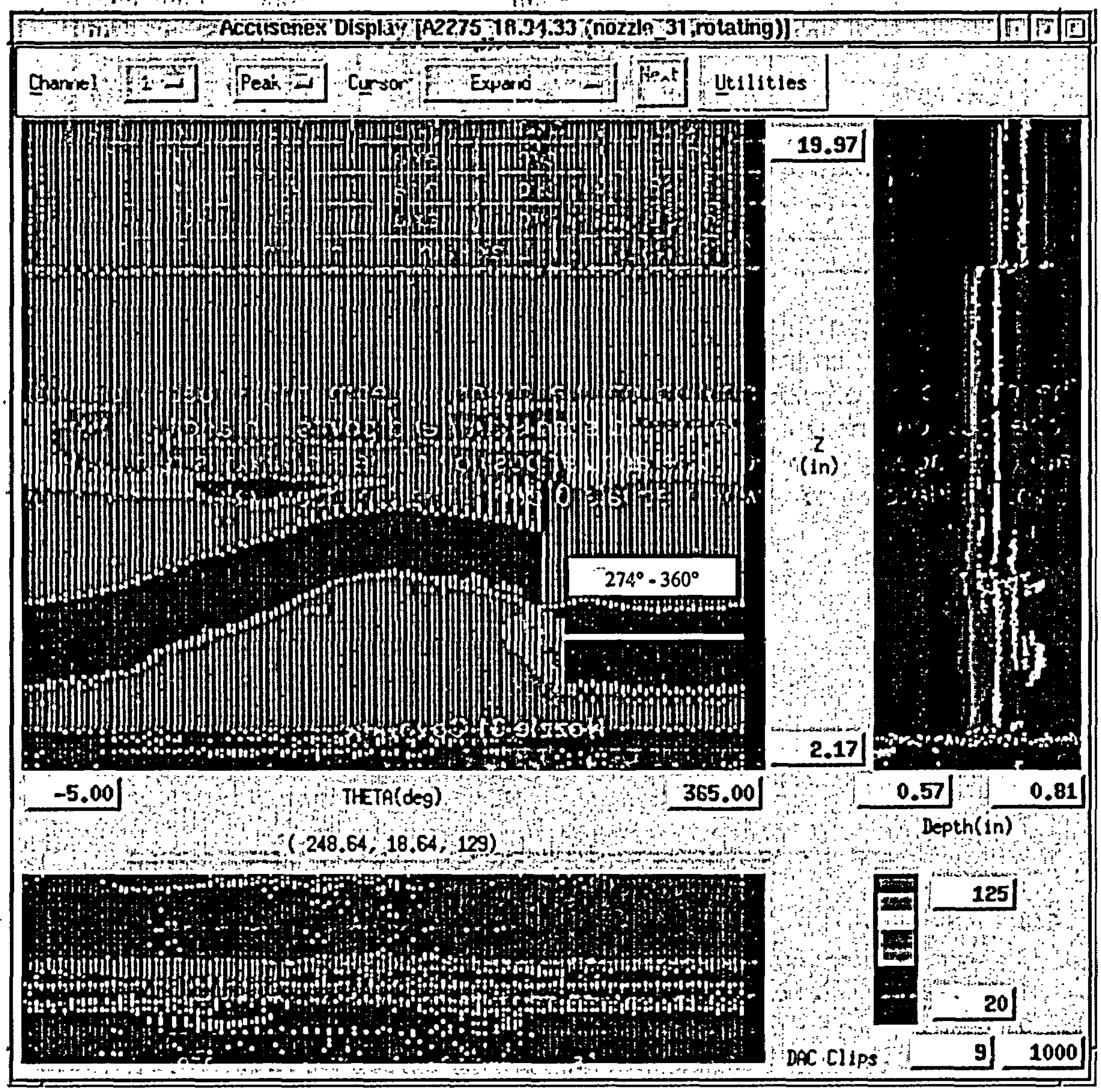
Nozzle 31

		Area effected:	min.:	max:	Total:		
			274	360	86		
	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	End
Nozzle 31	1	0	normal	vol	0	274	0
	2	30-L	axial	circ	338	252	338
	3	60-S	axial	circ	158	72	158
	4	45-LE	circ	axial	0	274	0
	5	60-SE	circ	axial	22	296	22
	6	60-SE	circ	axial	338	252	338
	7	0, 30L, 45LE	Leak Path		combined	274	338

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 31

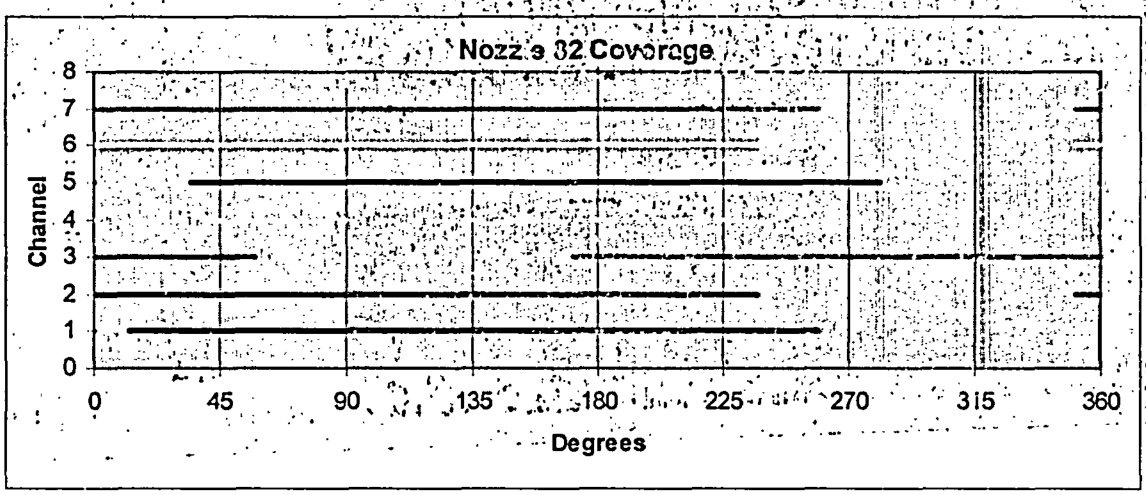


Horizontal line denotes the stall area.

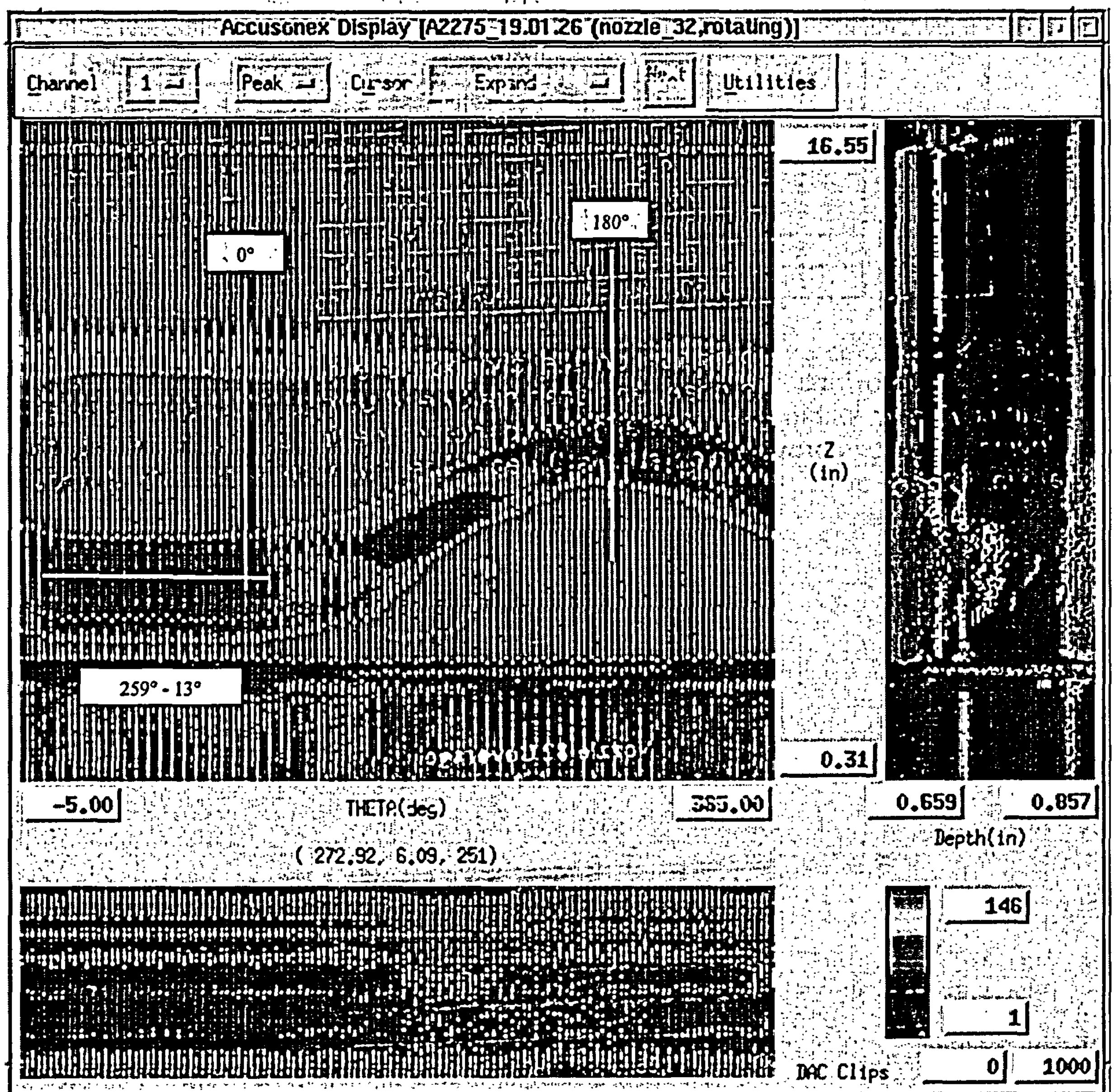
Nozzle 32

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 259	max: 13	Total: 127		
Nozzle 32	1	0	normal	vol	0	259	13
	2	30-L	axial	circ	338	237	351
	3	60-S	axial	circ	158	57	171
	4	45-LE	circ	axial	0	259	13
	5	60-SE	circ	axial	22	281	35
	6	60-SE	circ	axial	338	237	351
	7	0, 30L, 45LE	Leak Path		combined	259	351

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 32

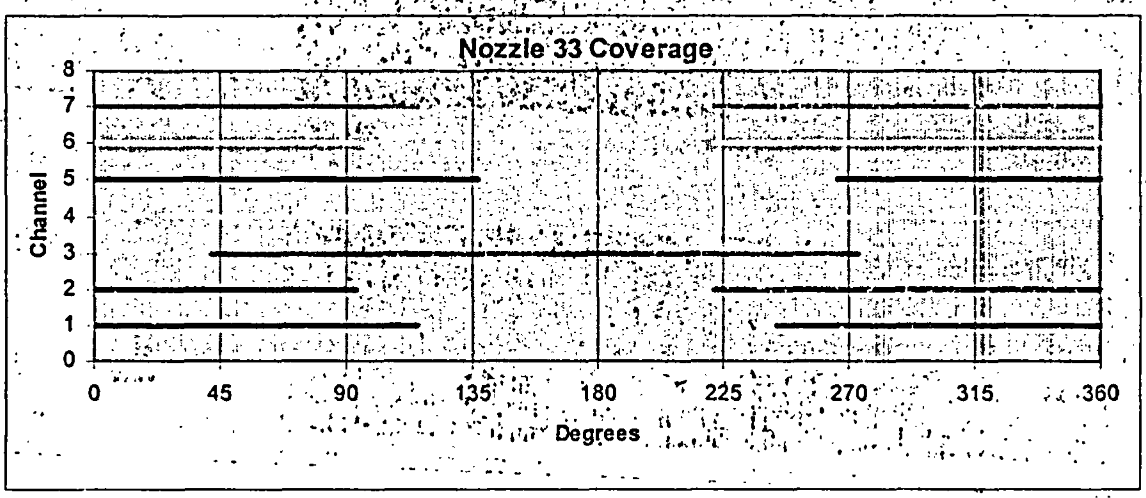


Horizontal line denotes the stall area.

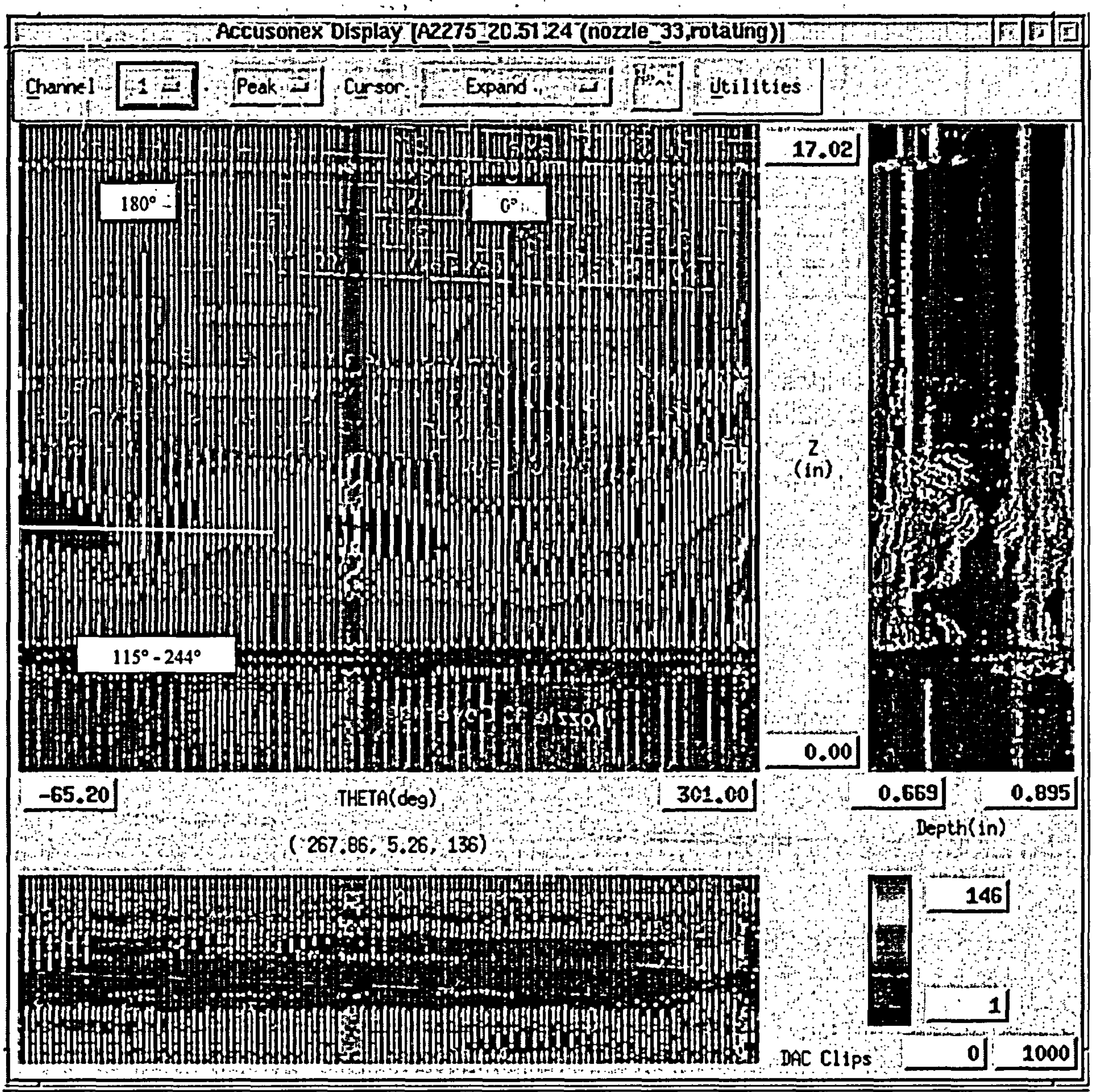
Nozzle 33

	Area effected:		min.:	max:	Total:		
			115	244	129		
	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	End
Nozzle 33	1	0	normal	vol	0	115	244
	2	30-L	axial	circ	338	93	222
	3	60-S	axial	circ	158	273	42
	4	45-LE	circ	axial	0	115	244
	5	60-SE	circ	axial	22	137	266
	6	60-SE	circ	axial	338	93	222
	7	0, 30L, 45LE	Leak Path		combined	115	222

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 33

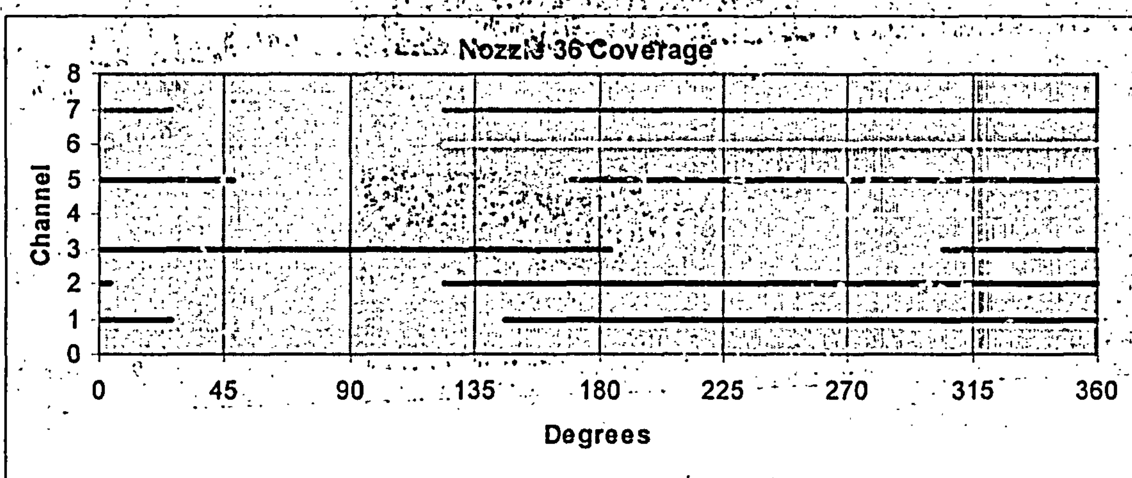


Horizontal line denotes the stall area.

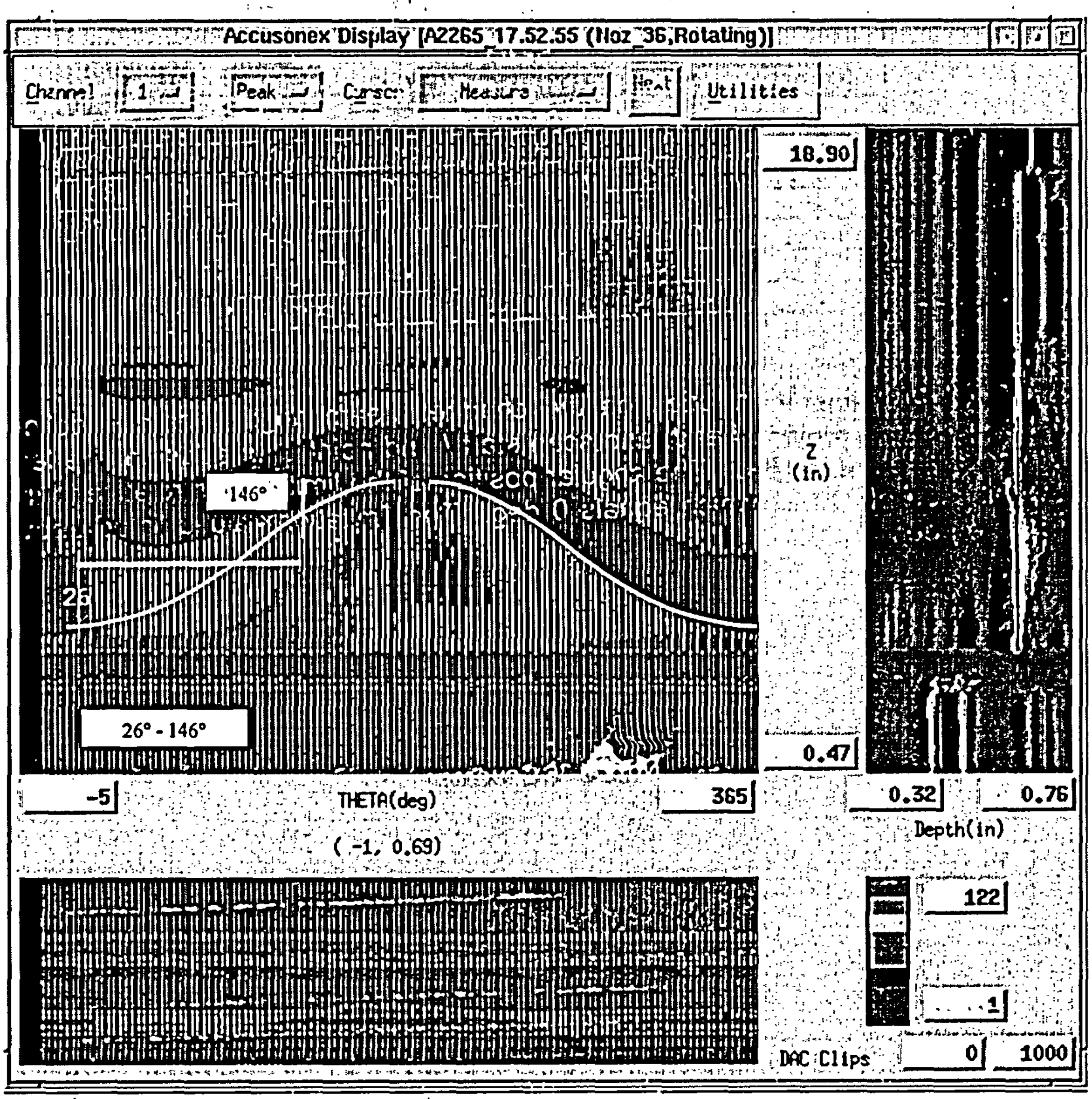
Nozzle 36

	Area effected:		min.:	max:	Total:		
			26	146	120		
	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	End
Nozzle 36	1	0	normal	vol	0	26	146
	2	30-L	axial	circ	338	4	124
	3	60-S	axial	circ	158	184	304
	4	45-LE	circ	axial	0	26	146
	5	60-SE	circ	axial	22	48	168
	6	60-SE	circ	axial	338	4	124
	7	0, 30L, 45LE	Leak Path		combined	26	124

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 36

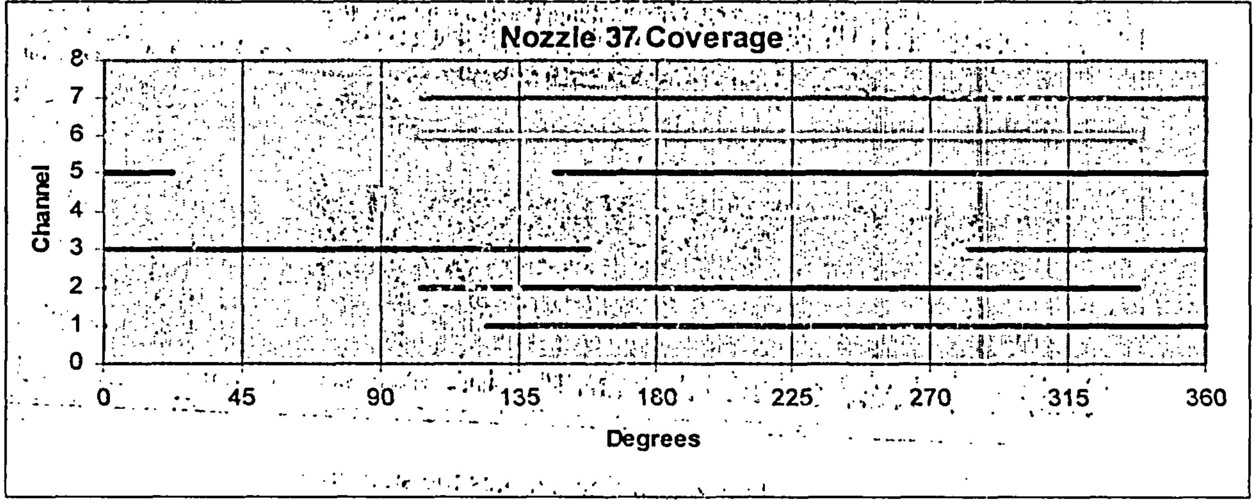


Horizontal line denotes the stall area.

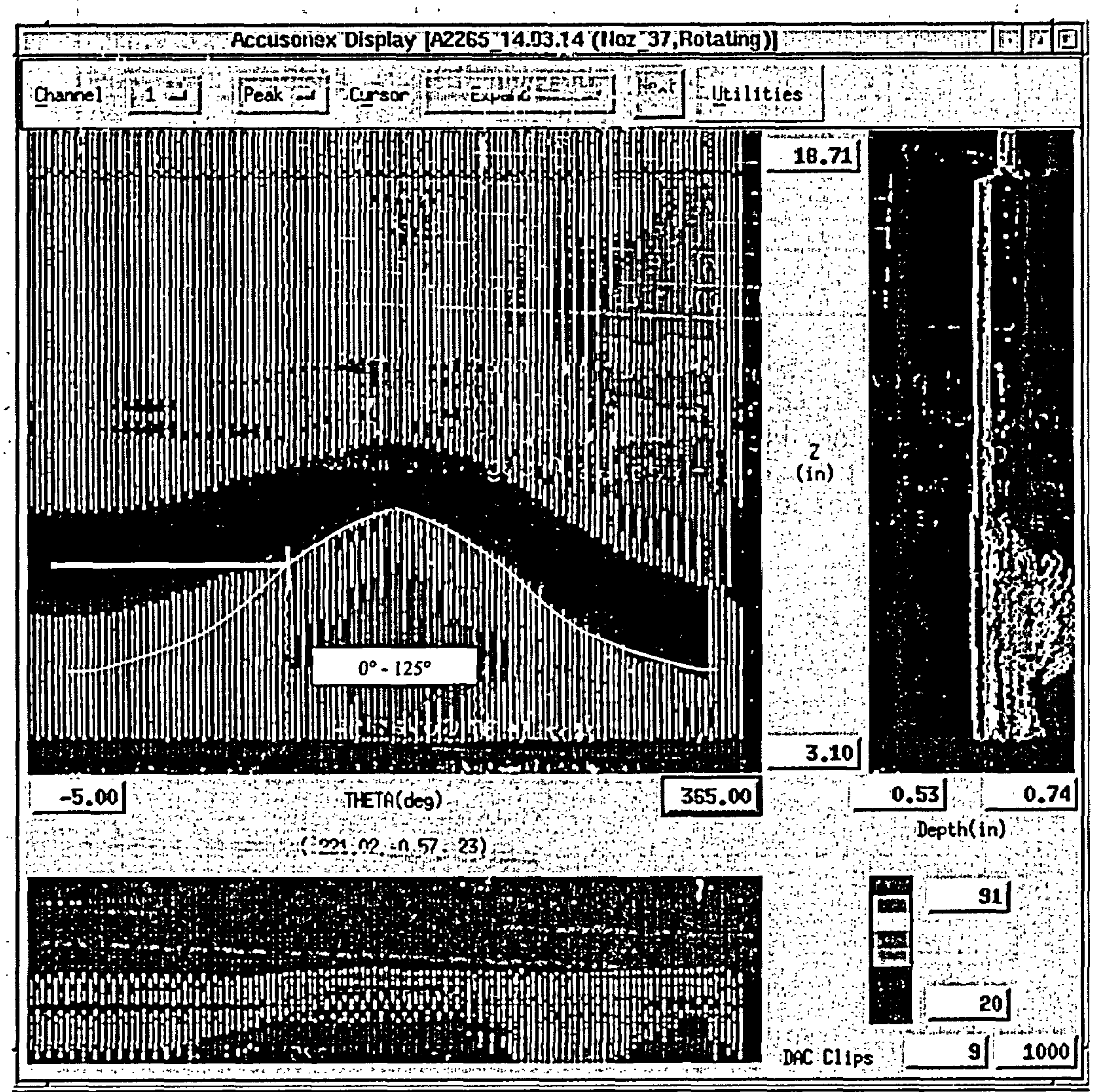
Nozzle 37

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 0	max: 125	Total: 125		
Nozzle 37	1	0	normal	vol	0	0	125
	2	30-L	axial	circ	338	338	103
	3	60-S	axial	circ	158	158	283
	4	45-LE	circ	axial	0	0	125
	5	60-SE	circ	axial	22	22	147
	6	60-SE	circ	axial	338	338	103
	7	0, 30L, 45LE	Leak Path		combined	0	103

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 37

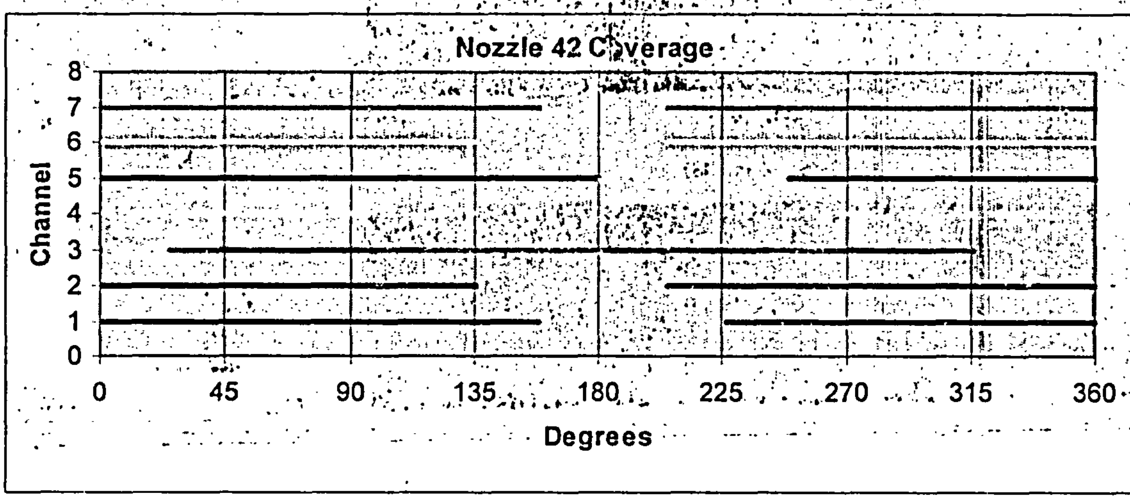


Horizontal line denotes the stall area.

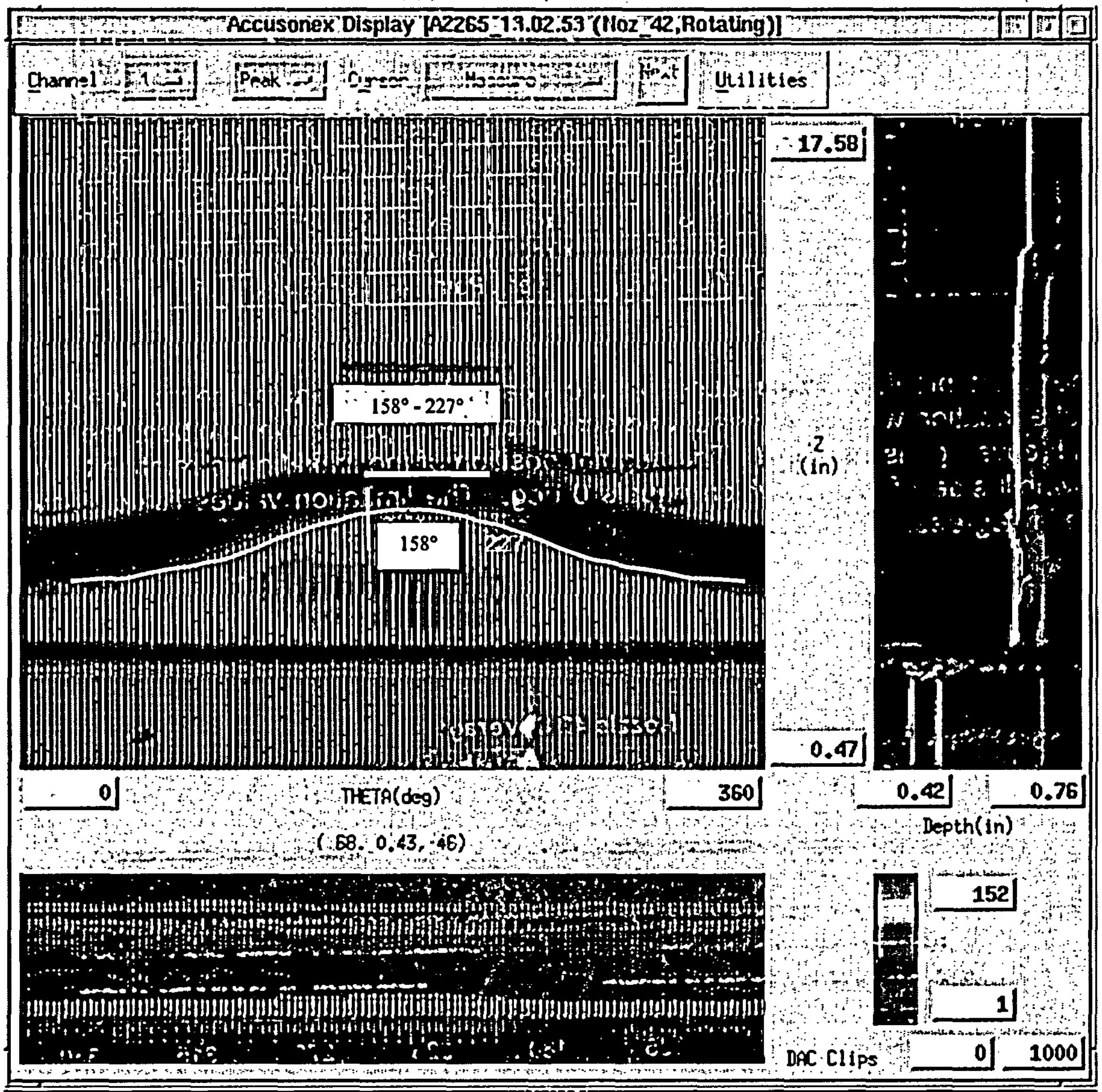
Nozzle 42

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 158	max: 227	Total: 69		
Nozzle 42	1	0	normal	vol	0	158	227
	2	30-L	axial	circ	338	136	205
	3	60-S	axial	circ	158	316	25
	4	45-LE	circ	axial	0	158	227
	5	60-SE	circ	axial	22	180	249
	6	60-SE	circ	axial	338	136	205
	7	0, 30L, 45LE	Leak Path		combined	158	205

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 42

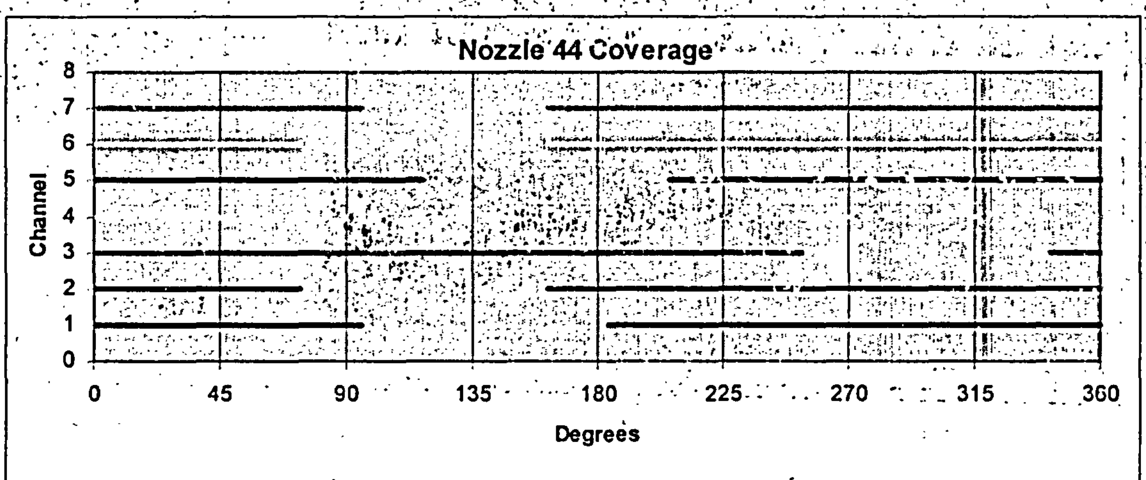


Horizontal line denotes the stall area.

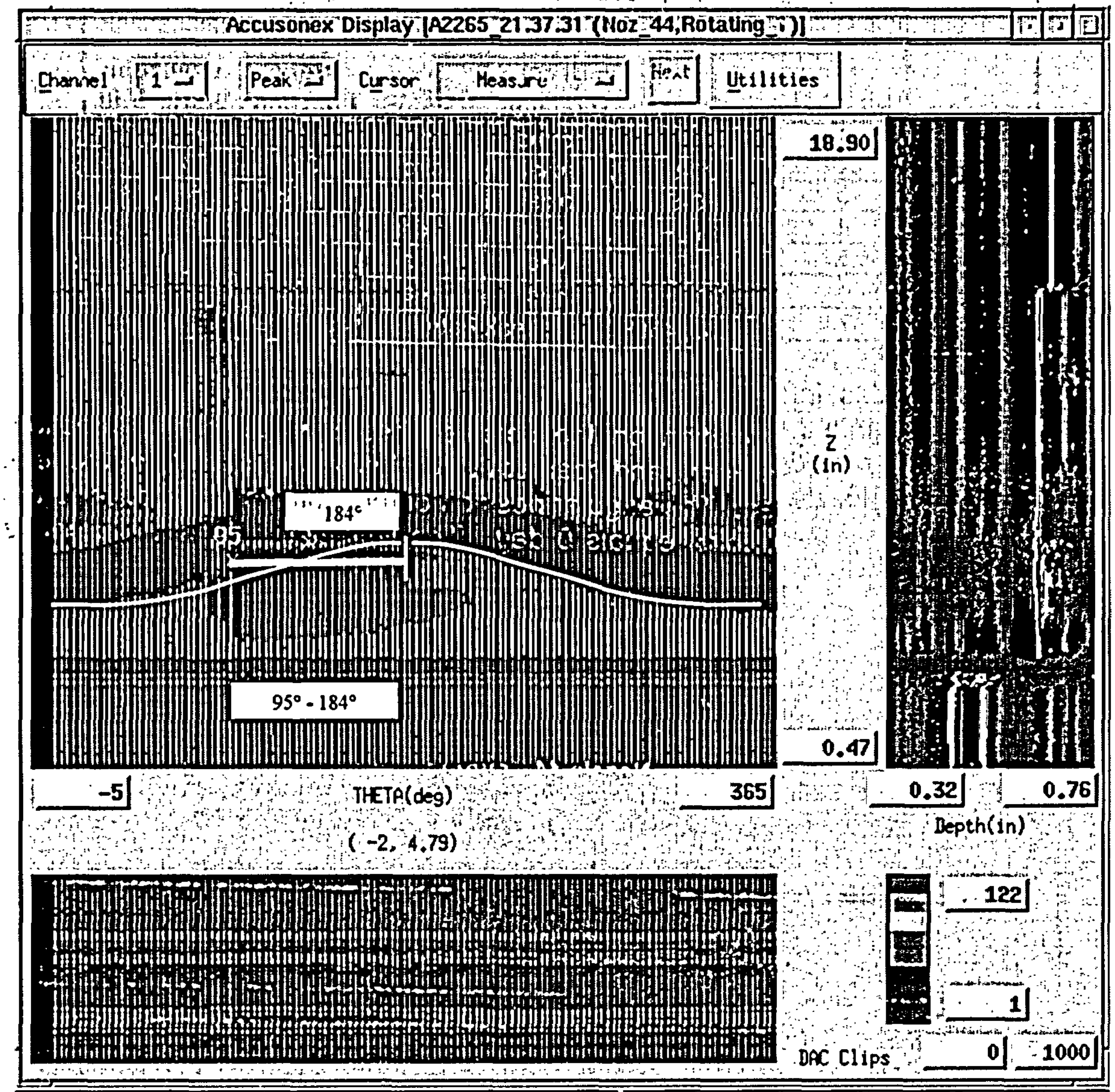
Nozzle 44

		Area effected:	min.: 95	max: 184	Total: 89			
	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	End
Nozzle 44	1	0	normal	vol	0	95	184
	2	30-L	axial	circ	338	73	162
	3	60-S	axial	circ	158	253	342
	4	45-LE	circ	axial	0	95	184
	5	60-SE	circ	axial	22	117	206
	6	60-SE	circ	axial	338	73	162
	7	0, 30L, 45LE	Leak Path		combined	95	162

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 44

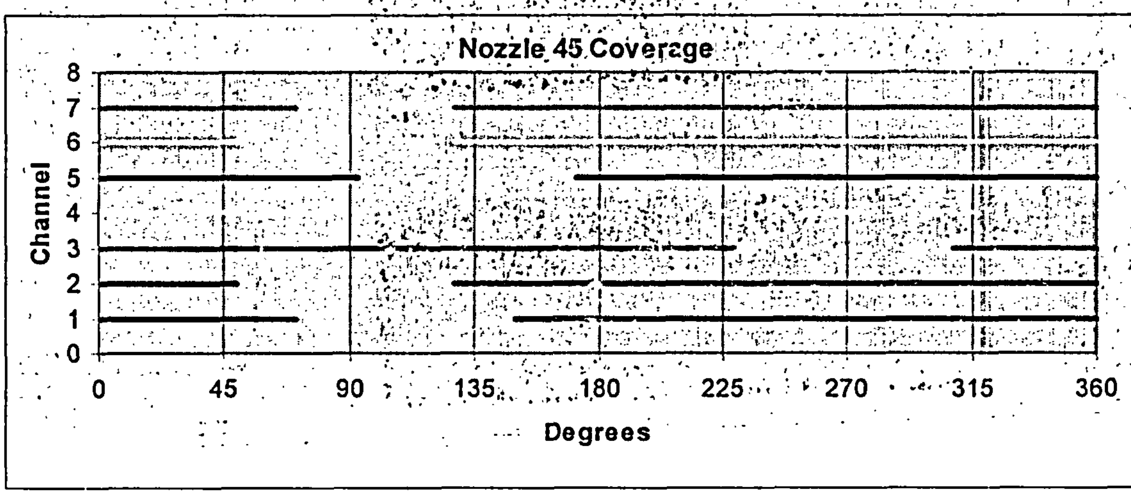


Horizontal line denotes the stall area.

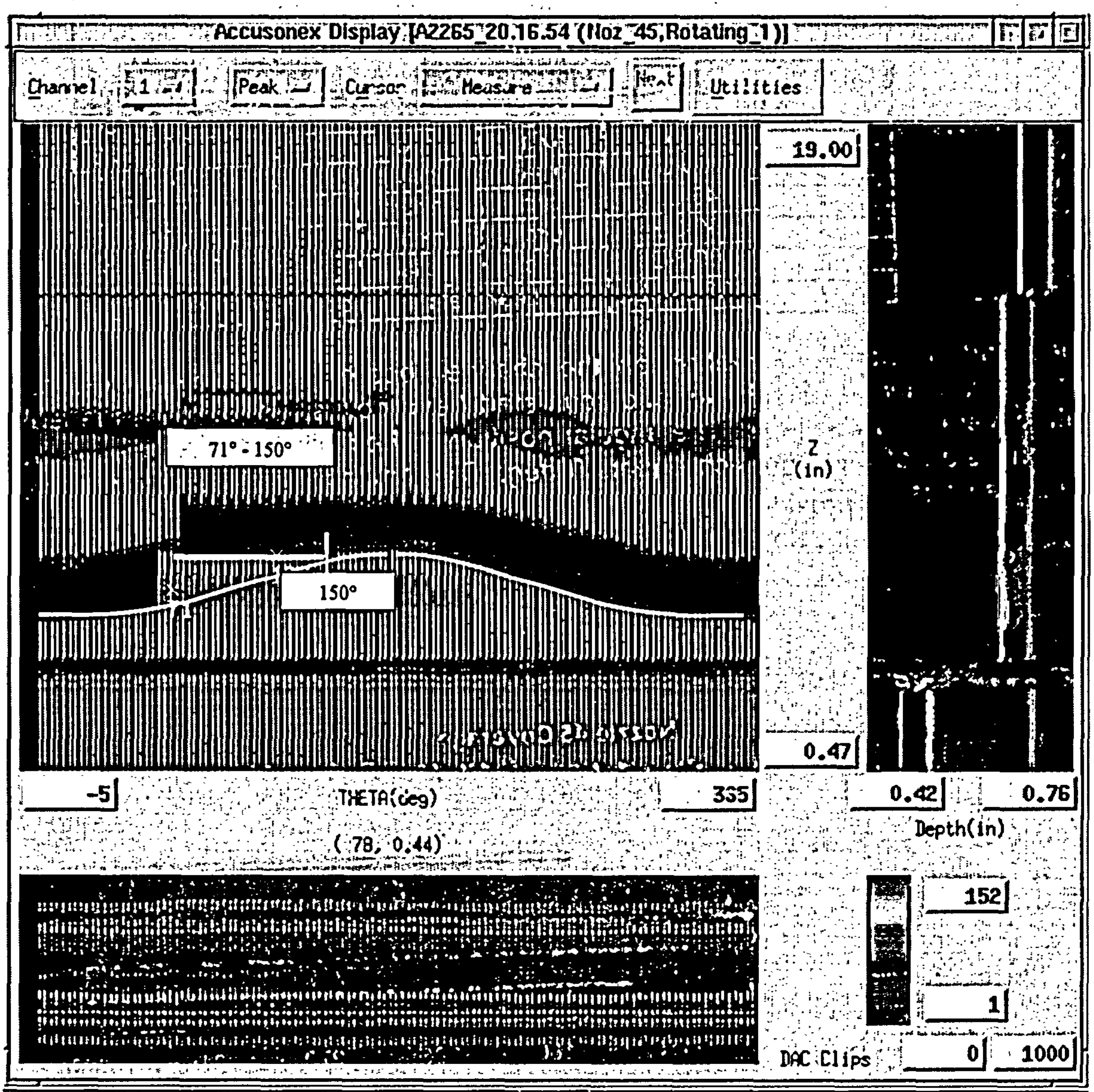
Nozzle 45

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 71	max: 150	Total: 79		
Nozzle 45	1	0	normal	vol	0	71	150
	2	30-L	axial	circ	338	49	128
	3	60-S	axial	circ	158	229	308
	4	45-LE	circ	axial	0	71	150
	5	60-SE	circ	axial	22	93	172
	6	60-SE	circ	axial	338	49	128
	7	0, 30L, 45LE	Leak Path		combined	71	128

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 45

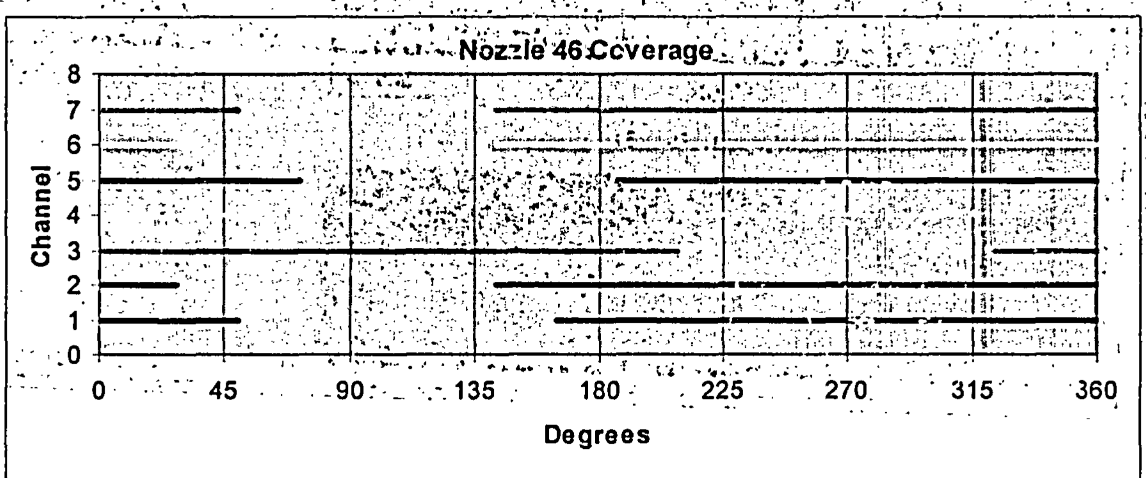


Horizontal line denotes the stall area.

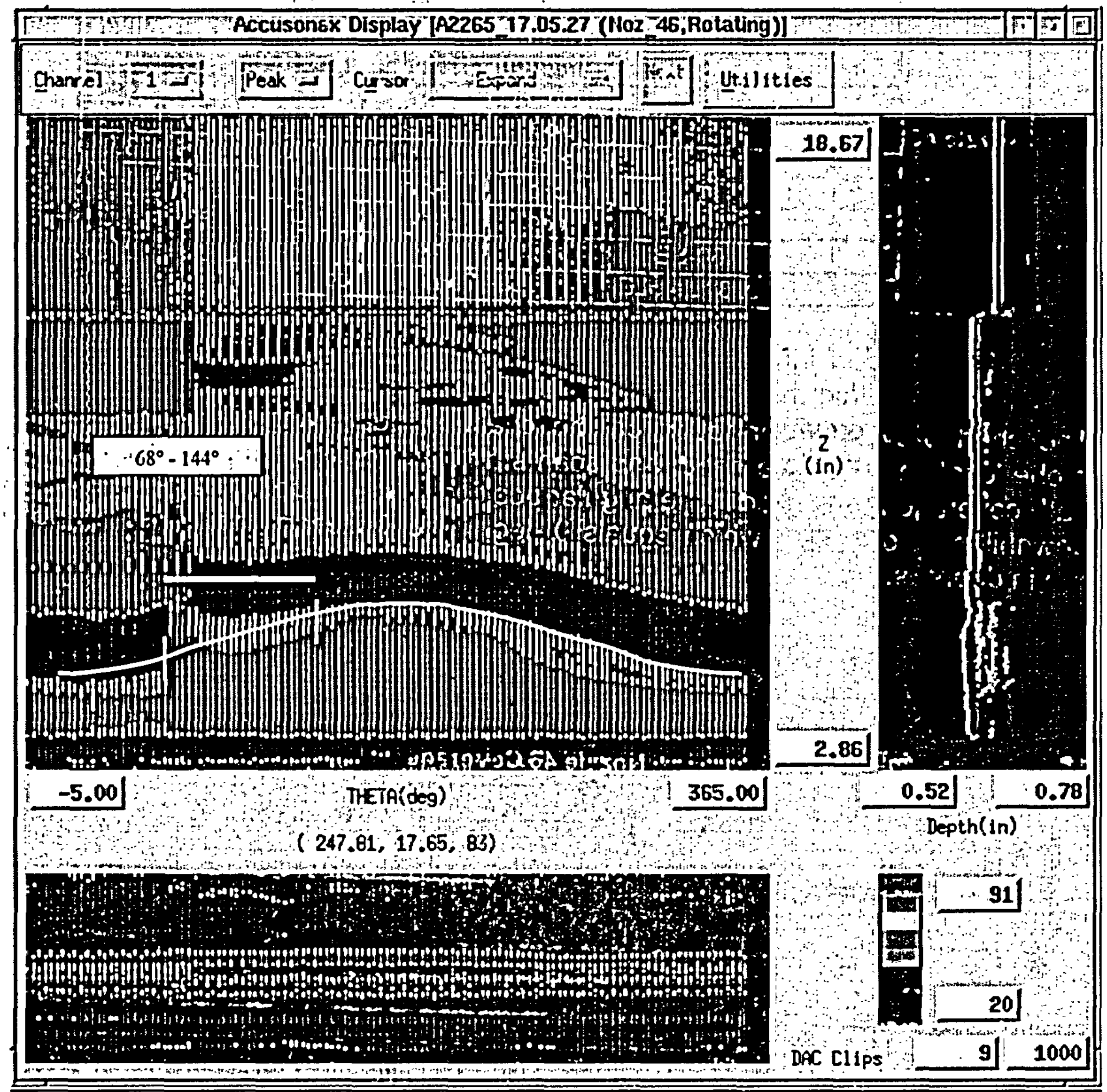
Nozzle 46

	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
	Area effected:		min.: 68	max: 144	Total: 76		
Nozzle 46	1	0	normal	vol	0	68	144
	2	30-L	axial	circ	338	46	122
	3	60-S	axial	circ	158	226	302
	4	45-LE	circ	axial	0	68	144
	5	60-SE	circ	axial	22	90	166
	6	60-SE	circ	axial	338	46	122
	7	0, 30L, 45LE	Leak Path		combined	68	122

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 46

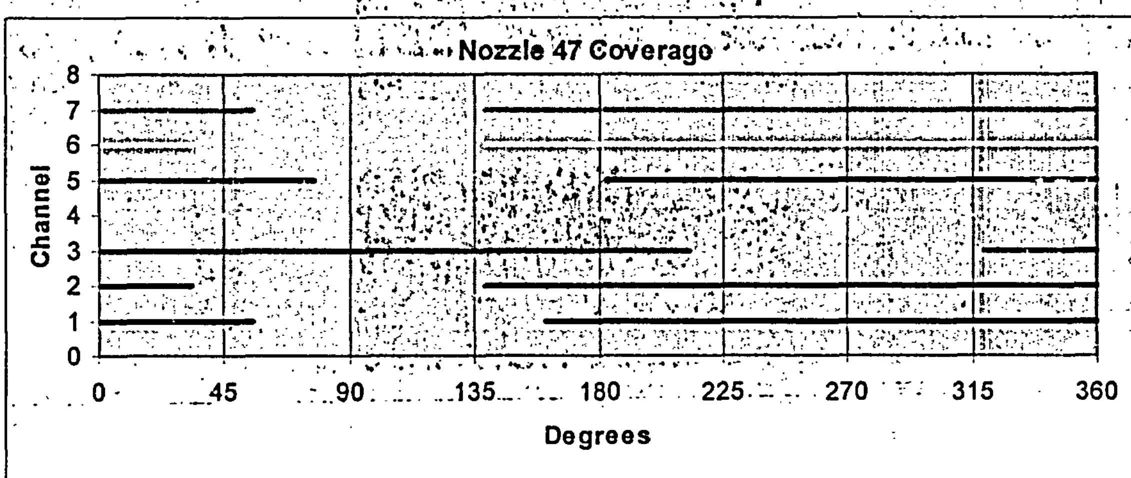


Horizontal line denotes the stall area.

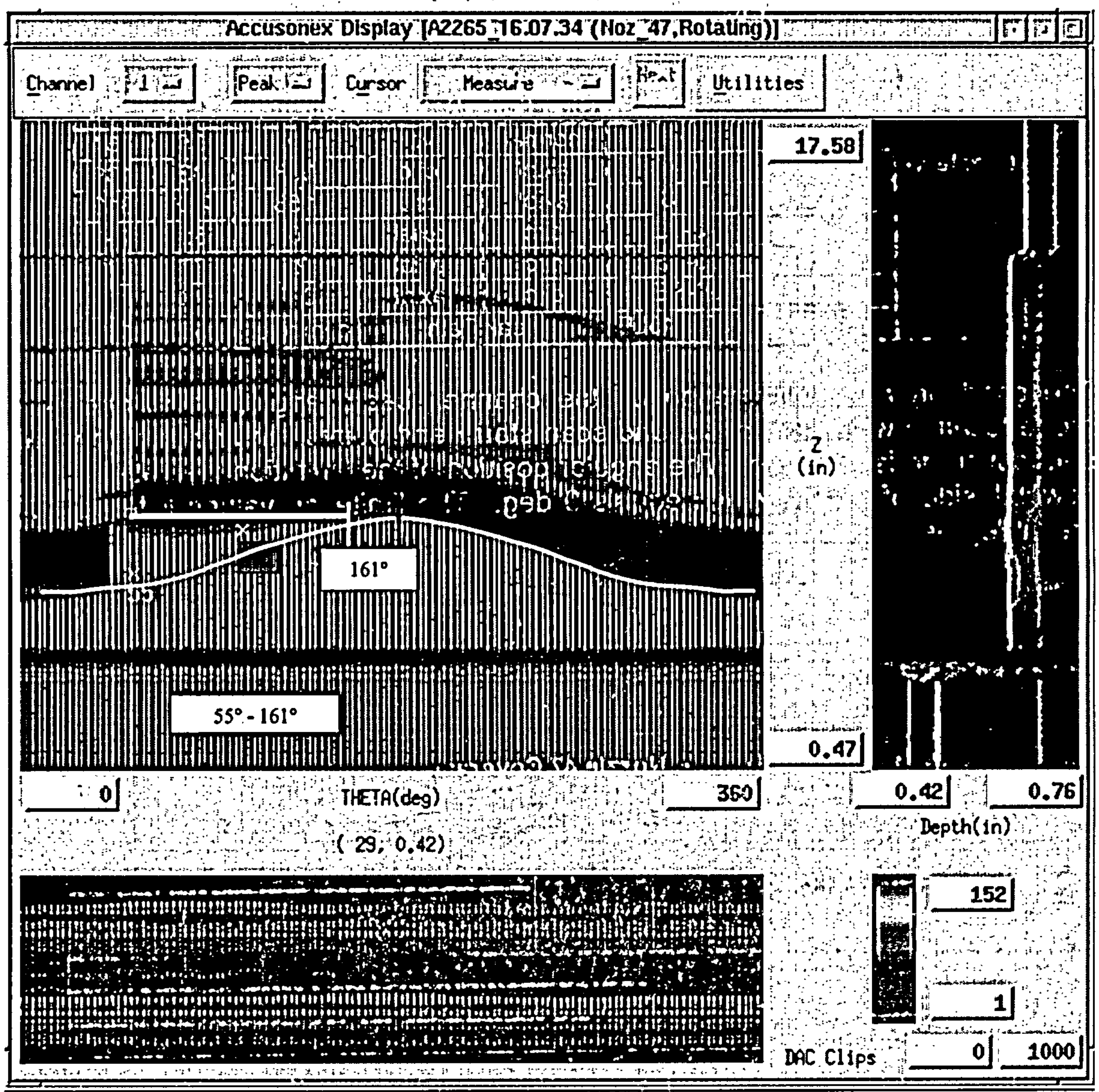
Nozzle 47

		Area effected:	min.:	max:	Total:		
			55	161	106		
	Channel	Degree	Beam Direction	Defects	Probe Location	Limitation Start	Limitation End
Nozzle 47	1	0	normal	vol	0	55	161
	2	30-L	axial	circ	338	33	139
	3	60-S	axial	circ	158	213	319
	4	45-LE	circ	axial	0	55	161
	5	60-SE	circ	axial	22	77	183
	6	60-SE	circ	axial	338	33	139
	7	0, 30L, 45LE	Leak Path		combined	55	139

The chart provides information on the channel, beam angle, beam direction, probe location within the head, and scan start / end points. In addition, the leak path coverage is provided. The angular position of the limitation is relative to the downhill side of nozzle which equals 0 deg. The limitation values listed above are in degrees.



Nozzle 47



Horizontal line denotes the stall area.

Bottom Up Rotating Transducer Head Configuration